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AIRCRAFT МиГ-19C
WITH CONTROLLED STABILIZER
DESCRIPTION
Book IV
SPECIAL EQUIPMENT

Declassified in Part - Sanitized Copy Approved for Release 2011/12/14 : CIA-RDP80T00246A062100060001-5

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This book covers purpose, principle of operation and arrangement of electrical, radio and instrument equipment.

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INTRODUCTION

Special equipment of aircraft MiG-19C (with controlled stabilizer) includes electrical equipment, radio equipment and instrument equipment.

I. The aircraft electrical equipment contains: power supply sources - two starter-generators ICP-CT-6000/A and storage battery, electrical inverter and loads; aircraft mains and switching gears controlling the power supply of various systems, stations and driven in the aircraft.

The electrical equipment ensures operation and control of various aircraft systems and units.

II. The radio equipment ensures fulfilling various types of radio communication and radio-location tasks as well as flight control and navigation.

The radio equipment includes:

1. U.S.V. station ICRV-4 for two-way communication.

2. Equipment for the instrument landing system by (I.L.S.-48N) comprising an automatic radio compass, type APK-5, radio altimeter, type PE-2, and marker receiver, type PTH-4CH.

3. Aircraft transponder, type CPO used for I.F.F. operation.

4. Airborne radar ranging unit, type CPK-1M, which operates in conjunction with automatic sight ACH-5M and puts target range in the latter when firing and sighting.

5. The SIGMA-2 tail warning radar warning of the attack from the tail by sending the signal to the pilot's headphone in case the aircraft is intercepted by the radar

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sight's beam of 3-cm. band radar ranging unit of the enemy aircraft from the rear.

III. The aircraft instrument equipment provides for correct employment of aircraft flight and tactical characteristics, proper heading and control of the power unit and various systems in the aircraft.

The instrument equipment includes:

1. Flight control and navigation instruments.
2. Instruments checking the power unit operation.
3. Instruments checking operation of separate systems and units in the aircraft.

The purpose, arrangement and operation of aircraft special equipment are presented in three Chapters of the given book.

- Chapter I - electrical equipment
Chapter II - radio equipment
Chapter III - Instrument equipment.

Chapter I ELECTRICAL EQUIPMENT

1. General

The aircraft is provided with 28.5-V single-wire circuit.

Two starter-generators, type ICP-CT-6000A, parallel-connected into the aircraft mains serve as the main power supply source. The emergency power in the aircraft is derived from type 12CAM-28 storage battery connected in parallel to the generators and the aircraft mains. The power supply from the generators is fed via the JNP-400A type minimum differential relays to the distributing busbars in the starboard and port power supply units arranged above the aircraft axis, over the wing beam fillets between frames 13 and 14.

Coming from the distributing busbars arranged in the starboard and port power supply units the power is fed, via the main circuit breakers mounted in the starboard and port power supply units (five pieces per each), to the feeder circuit breakers mounted in the pilot's cockpit on the starboard and port consoles from which the power is supplied to the loads.

The power is partially fed from the power supply units to the following units:

From the port power supply unit:

1. To the control system power equipment of nozzle eyolids.
2. To buster pump 495A mounted in the lower part of the first tank.

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3. To the HO-750 inverter feeding the sight and radar ranging unit.

From the starboard power supply unit:

1. To stabilizer control actuator MVC-2 cut in with a pressure drop in the hydraulic system.
2. To the computing unit of variable ratio boost control unit APV-2A in the cockpit.

To connect the ground supply to the aircraft mains provision is made for a special four-pin receptacle (plug) mounted on the port side, lower portion, between frames 18 and 19, from which the positive wire runs to the PNA-200A relay box installed on the port side from below, between frames 12 and 13. From terminal B of the ground supply relay box, type PNA-200A, the wire runs to the port power supply unit.

The ground supply is switched on from the pilot's cockpit by means of a switch marked AIRBORNE STORAGE BATTERY, GROUND SUPPLY (АККУМУЛЯТОР БОРТОВОЙ, АЭРОПРОМНЫЙ) mounted on the starboard front electric panel. The PNA-200AX^x relay box cut into the ground supply power circuit is employed for:

1. Remote connection of the ground supply.
2. Keeping power source with a reversed polarity off.
3. Automatically cutting off the airborne storage battery (when the ground supply is cut in).
4. Automatically cutting off control circuits for switching generators on or off.
5. Keeping powerful loads off the airborne storage battery (sight, radar ranging unit). The power for starting the engine on the ground is drawn either from a generator mounted on the type AN-7 automobile or from CT-2 starting

^{x/} From series 7-45 on, the PNA-200M relay box is used instead of the PNA-200A type.

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truck or from other power sources of ground supply and, in case of emergency the airborne storage battery, type 12CAH-28, is used. The TCP-CT-6000A starter generator together with starting and adjustment equipment is used for starting the engines.

1. The aircraft electrical loads are:

- (a) starter-generator;
- (b) starter starting box;
- (c) starting pump;
- (d) starting ignition coils - two pieces;
- (e) booster pump in the first tank;
- (f) electromagnetic starting fuel valve - 2 pieces;
- (g) pressure oil warning lamps - 2 pieces;
- (h) ignition warning lamps - 2 pieces;
- (i) PA-21 two-way valve electromagnet - 4 pieces (2 pieces per each engine for adjustable nozzle eyelids control);
- (j) by-pass band electromagnetic valve;
- (k) electric pumps in the second, third and fourth tanks.

2. Engine throttle electric control units installed in the AFTERBURNING and MAXIMUM circuit.

3. Communication radio station.
4. Radar equipment.
5. ACP-5H sight.
6. Cannon armament.
7. Bomb load.
8. Rocket armament.
9. Camera guns.
10. Fire-fighting equipment.
11. Control electric actuators of hydraulic and air systems, I.G., and wheel braking system.
12. Electric actuators of the controlled stabilizer.
13. Cockpit air-temperature regulation units.

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14. Warning illumination equipment.
15. Flight control and navigation instruments.
16. Engine instruments:
 - (a) fuel quantity gauge and flowmeter;
 - (b) kerosene meter with warning system.
17. Navigation lights, landing and taxiing lamps.
18. Electric signal flare launcher.
19. Heater of the air speed tube, clock and TH-156 pitot tube.

The electric mains is protected against overloads and short-circuits by:

- (a) Type A3C circuit breakers.
- (b) The circuits liable to catching fire are provided with type A3P circuit breakers with a release mechanism.
- (c) The TH heavy current fuses provided in the circuits of the airborne storage battery and starter-generators.
- (d) The A.C. circuits are protected with type CH fuses mounted in the relay box under the cockpit floor (type CH fuses are likewise mounted in the D.C. circuits: in the supply system of the radio, voltmeter, landing and taxiing lamps, etc.).

(e) To protect the loads and their supply circuits with increased starting currents provision is made for use of inertia-type fuses, type MH.

To designate the wire and units in the aircraft, a letter-digit system is used, consisting in the following: The entire aircraft electric equipment is divided into groups (depending on its purpose).

Each of the main equipment groups is prefixed with the first letter of the unit name.

Thus, the radio supply group is denoted with the (Russian) letter P, illumination and warning equipment with C etc. This makes it possible to determine the unit the respective wire belongs to. The wire tag indicates the

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number of electric line, terminal and section. For instance 5-4PI-II.

The entire aircraft power system is divided into feeders.

These are:

1. Power supply unit.
2. Engine starting system.
3. Fire-fighting facilities, electric instruments, generators operation warning system, pump pressure warning system in the first, third and fourth tanks.
4. Engine MAXIMUM and AFTERBURNING automatic control.
5. Engine fuel feed shut-off cocks control.
6. Control of de-icer, air-distributing cocks, 3VN-53, cockpit lamp, type KACPK-45.
7. Automatic brake arrangement.
8. Supply of radio altimeter, type PB-2, radio marker receiver.
9. Supply system of radio stations, type PCMV-4, APK-5, CPO, and fuel quantity gauge and flowmeter.
10. Radar ranging unit supply system.
11. SIRENA tail warning radar station supply system.
12. Supply system of TH-156 velocity head emergency pitot tube heater.
13. Aileron trim tab and stabilizer trim tab effect mechanism control.
14. Stabilizer emergency control system supplied from DP-5 with pressure drop in hydraulic system.
15. APY-2A system of controlled stabilizer.
16. Gyro induction compass and gyro horizon APW-1.
17. APW-1 gyro horizon emergency supply system.
18. Landing and taxiing lamps control system.
19. Sight supply system.
20. Cannon and bombing equipment control system.
21. The port wing cannon feed and charge system.

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22. Fuselage cannon feed and charge system.
23. The starboard wing cannon feed and charge system.
24. AKC-3M and CM-45 camera guns supply system.
25. Rocket armament supply system.
26. Bombing armament tactical supply system.
27. Bomb emergency release and tank jettisoning system.
28. Type PB4-4 air speed tube and clock heaters.
29. Landing gears and air brakes warning system; air brakes control system; pressure warning system of hydraulic system and navigation lights.
30. Stabilizer and aileron boosters control system.
31. APV40M-45 ultra-violet irradiation equipment, portable lamp and signal flares.
32. Landing gear retraction and extension control, brake parachute release and drop control, flaps control and warning system.
33. 2nd tank pump pressure supply and warning system.
34. 3rd tank pump supply.
35. 4th tank pump supply.

The main electric power source in aircraft is ensured by two starter-generators, type ICP-CT-6000A, complete with control equipment:

- (a) P-27 voltage regulator;
- (b) DMP-400A differential minimum relay;
- (c) TC-9AM stabilization transformer.

The P-27 voltage regulator serves to maintain the generator constant voltage irrespective of its speed and the mains load; the DMP-400A relay provides for cutting the generator into the mains in case its voltage is 0.3 - 0.7 V higher than that in the mains and cuts it off if the current is of the reverse direction (from the aircraft mains to the generator), its value being 15 - 35 A.

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Starter-Generator, Type ICP-CT-6000A

The ICP-CT-6000A starter-generator is a six-pole D.C. unit with three additional poles.

The ICP-CT-6000A generator is designed as an enclosed type electric machine mounted on the closed bearings. The drive is effected through a reduction gear unit having a ratio of 1.25 when used as a generator and of 0.356 when used as a starter. The shaft serves to connect the motor reduction gear.

The sense of rotation is clockwise as viewed from the reduction gear side.

The generator is cooled with the head (outboard) air stream and with the fan mounted in the generator frame.

When used as a generator, the starter-generator operates with parallel excitation together with the P-27 voltage regulator, DMP-400A differential minimum relay, EC-6000 ballast resistor and TC-9AM transformer. The above equipment is used for:

- (a) ensuring parallel operation of a storage battery and the generators;
- (b) ensuring parallel operation of both generators and reducing amplitude and duration of voltage fluctuation with changing the motor duty.

Specifications

Rated voltage	28.5 V
Power (at 30 V)	6000 W
Rated load current	200 A
Operating speeds	4000 - 9000 r.p.m.
Maximum 1-min. load current within	
5000 - 8000 r.p.m.	300 A
Maximum permissible load current without	
scavenging for 30 min.	60 A

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Air necessary for cooling not less than $75 \text{ dm}^3/\text{sec}$

Starter Mode of Operation

(a) With 21 V voltage across the terminals and compound excitation the starter-generator should develop a speed of 1400 r.p.m., its torque being 1.8 kg-m. The drawn current should not exceed 260 A.

(b) With 21 V across the terminals and series excitation, the starter-generator should develop a speed of 2400 r.p.m., its torque being 1.1 kg-m. The drawn average current should not be in excess of 260 A.

When used as a starter the unit employs two excitation windings (series and parallel ones).

In the first phase of motor starting they operate jointly. Then to increase the rate of speed, the parallel winding becomes cut off and only the series winding remains in operation throughout the entire starting period.

When used as a generator, the series winding is cut off.

2. Protection Equipment

To protect electric power sources from overloads and short-circuits the power lines are provided with heavy current fuses TH-400 (293), TH-200 (209 and 219).

To safeguard the wiring and D.C. loads against overloads and short-circuits the circuit is provided with two types of circuit breakers (A3P and A3C) and fuses, type TH, NH and CH.

According to fire prevention measures even short periods of overloads in wires, circuits and units are not allowed; therefore the A3P circuit breakers with a release mechanism are mounted in the circuits.

The A3C circuit breakers with their possible connection by force are installed in the circuits where, according to

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tactical considerations, it is necessary to keep the protected circuit closed in spite of overloads (for instance in armament circuits).

To protect the A.C. loads against overloads or short-circuits, type CH, fuses are employed. These are placed in some D.C. circuits as well.

The A3P type circuit breakers are provided in the circuits of the second (14M), third (17M) and fourth (18M) fuel tank pumps.

The protection means are not concentrated in one place. They are arranged as follows:

1. In the port and starboard power units (group protection).
2. On the port and starboard panels in the cockpit.
3. In the relay box under the cockpit floor.

A3P Operation

With the circuit current load increasing, the circuit breaker bimetallic plate automatically opens the circuit.

The circuit breaker operates both when the handle is kept in the ON position or when it is allowed to return to its initial position, i.e. the A3P circuit breaker is equipped with a free trip.

The contacts may be opened manually by using a handle as well. As to its design the type A3P circuit breaker is actually a double-break switch.

3. Electric Wiring

Electric wiring is made of wire, mark ENBM and ENM.

Note: To reduce thermal effects the electric wires used in the tail section are additionally wound over with asbestos cord and coated with tapes LAC and ANSM.

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To decrease radio interference some wires and bunched conductors are provided with metallic shielding.

The end of each wire carries a tag with coding consisting of letters and figures and based on the following principle:

(1) The aircraft's electric equipment is divided into groups depending on the application.

Each group has a letter which stands as follows:

- S - power supply unit (power sources)
- M - actuators
- E - ignition units
- K - engine control instruments
- C - light signalling and illumination
- H - navigation instruments
- P - radio equipment
- II - cannons, sight, camera guns, rocketry
- B - bombs (drop tanks)
- T - heating of instruments.

(2) All instruments and equipment of each group above have index numbers of the respective group.

(3) A tag of any wire shows, say, 9-51M-11:

(a) Index number of unit to which wire is connected (51).

(b) Letter code of electric equipment group (M).

(c) Number of electric line (index numbers of lines depend on quantity of leads running from given unit) - (1).

(d) Number of line section running from unit to unit, unit to connector, or splitter box, or other equipment (11).

(e) Number of a terminal (contact) to which the wire (connector, box, instrument or other apparatus) is connected (9).

A. Electric Circuitry

(A) Connected to busbar of port generator are:

Busbar No.1 - through circuit breaker (A3C-30, (343).

Four electromagnetic valves PA-21 (74M, 75M, 84M, 85M) for controlling adjustable area eyelids through circuit

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breaker A3C-10 (88M) and contacts of relays A, K, P, E, B, A of afterburner control unit KAQ-2 (3M).

Booster pump 495A (30M) through circuit breaker A3C-40 (85B).

Inverter HO-750 (17P) for power supply of radar ranging unit CPD-1M and sight ACN-5HB3 through WH-75(32P).

Connected through circuit breaker A3C-10 (31P) and switch 87K (16P) are:

Relay PH-6 (5P) for emergency switching on the power supply of the radio stations.

Unit B-1 PCMY-4, control desk of the CPO transponder and control board APK-5 (13P) via contacts 6-5 of emergency relay (5P) and fuses CH-10 (36P), (37P) and (35P).

Through contacts 6-5 of relay PH-2 (21p) and contacts 4-5 of relay PH-2 (44M) electric energy is supplied to terminal 4 of inverter HO-750 (17P) which ensures its starting.

(B) Connected to starboard generator are:

Busbar No.2 through circuit breaker A3C-30 (313).

Busbar No.3 through circuit breaker A3C-40 (333).

Busbar No.4 through circuit breaker A3C-25 (323).

Busbar No.5 through circuit breaker A3C-30 (31M).

Inverter HO-750 (2P) for power supply of stations PCMY-4, APK-5, MPH, CPO and flowmeter through fuse WH-75 (30P);

Computer unit of the APV (variable ratio automatic boost control unit) (105M) through circuit breaker A3C-15(102M).

Through circuit breaker A3C-30 (101M):

V-1 fuse WH-10 (162M) and A3C-5 (116M) - limit switches (40M and 118M) which close at a pressure drop in hydraulic system and supply winding of contactor which cuts in the electric actuator KM-25A (72M).

Electromotor of actuator MYC-2 (113M) when contactor KM-25A (72M) is cut in.

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Reversible electromagnetic clutches of electric actuator WYC-2 (113M) through mismatch transmitter ДР-5 (91M) when contactor KM-25Д (72M) is out in.

Busbar No.1

Connected to busbar No.1 are:

Through circuit breaker АЗС-25 (1E):

Starting units of engines.

Through circuit breaker АЗС-5 (86M):

Afterburner units of port engine.

Through circuit breaker АЗС-5 (87M):

Afterburner units of starboard engine.

Through circuit breaker АЗС-5 (11M):

Contactor KM-50Д (363) used for turning on pump 495A and timer АВН-1BE in starting panel (1M).

Through circuit breaker АЗС-5 (5K):

Cut-out pilot lamps СМЛ-51 (1C) and (2C) of port and starboard generators.

Fuel pressure warning mechanism СД-3 (7K) and fuel pressure pilot lamp СМЛ-51 (8K) of drop tanks.

Indicator of fuel quantity gauge and flowmeter (14K);

Fuel pressure warning mechanism СД-3 (3K) of 3rd and 4th tanks and pilot lamp СМЛ-51 (4K) indicating operation of 3rd and 4th tank pumps.

Fuel level pilot lamp (15K).

Thyratron interrupter (17K).

Discharge bonnet of fire-extinguishing bottle (32K) through switch button 205K (31K).

Fire warning relay ПН-3 (35K) along minus circuit via three thermostats АД-155А-3К (30K).

Pressure warning mechanism СД-3 (6K) of 1st kerosene tank which contacts close at pressure less than 0.3 kg/sq.cm. and make power supply circuit for winding of relay M in

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КАВ-2 (3M). When relay operates, lamp (12K) of 1st tank comes on, while afterburning and maximum engine power become out out.

Fire warning lamp СМЛ-51 (10K).

Through circuit breaker АЗС-5 (5C):

Thermoregulator ТРТБК (3T) of air in cockpit and electric air distributor (4T) via switch ПЭПН-20 (2T) marked СОСКИТ SUPPLY (ПИТАНИЕ КАБИНЫ), COLD, HOT, AUTOMATIC (ХОЛОДНЫЙ, ГОРЯЧИЙ, АВТОМАТ);

De-icer electromagnetic valve ЗК-48 (9T) via button 5K (8T).

Turn indicator ЭВН-53 (16H).

Cockpit lamp КЛСРК-45 (51C).

Left rear lamp АРУОМ-45 (41C) and its rheostat РУО-45 (40C).

Through circuit breaker АЗС-5 (19M):

Electric valve ЗК-48 (21M) with port engine shut-off cock button 205K (20M) depressed.

Maximum oil pressure warning lamp (19K) of port engine via closed contacts of oil pressure warning mechanism ЗСДУ-5 (18K).

Through circuit breaker АЗС-5 (22M):

Electric valve ЗК-48 (24M) with starboard engine shut-off cock button 205K (23M) depressed.

Maximum oil pressure warning lamp (21K) of starboard engine through closed contacts of oil pressure warning mechanism ЗСДУ-5 (20K).

Through circuit breaker АЗС-5 (25M):

Three electrically operated pneumatic valves УП-30/1 (27M, 29M and 76M) and relay ПН-2 (68M) via contacts of pneumatic switch УП-22 (26M). Switch closes contacts only when compressed air is supplied to wheel braking system while pneumatic valves operate only when inertia transmitters ЯА-23 (28M, 30M) and ЯА-24 (77M) become brought into play.

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Busbar No.2

Connected to busbar No.2 are:

Through circuit breaker A3C-5 (33P):

Marker receiver MPN-48H.

Bell of MPN-48H (28P).

Marker lamp.

Receptacle 48K (27P) for connection of PB-2 through filter 034-1E (29P).

Through circuit breaker A3C-10 (3p):

Control board APK-5 (13p) via contacts 4-5 of relay PN-6 (5p) and fuse CH-10 (35p).

Control desk of CPO station (9p) via contacts 4-5 of relay PN-6 (5p) and fuse CH-10 (37p).

Rectifier of station PCNV-4 (12p) via contacts 4-5 of relay PN-6 (5p), fuse CH-10 (36p) and via contacts 2-3 of relay PN-2 (4p) with switch 87K (1p) ON.

Via contacts 1-2 of relay PN-6 (5p), to terminal 4 of inverter IO-750 (2p) which ensures starting of the latter.

Through circuit breaker A3C-10 (15p):

Control desk of radar ranging unit CPD-1M (22p) via contacts 4-3 of relay MP-1 (45H).

Relay for cutting-in radar ranging unit PN-2 (21p).

Via contacts 6-5 of relay PN-2 (21p) and contacts 4-5 of relay PN-2 (44H) to terminal 4 of inverter IO-750 (17p) which ensures starting of inverter with sight circuit breakers (42H) and (1H) OFF.

Through circuit breaker A3C-5 (23p):

Control desk of tail warning radar SIRENA (24p).

Through A3C-10 (10T):

Heater of impact pressure tube TH-156 (7T).

Through circuit breaker A3C-5 (1H):

Inverter IAP-10H (2H) for power supply of AIM-1 (gyro horizon) on emergency duty and relay PN-3 (13H).

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Through circuit breaker A3C-10 (4H):

Inverter IT-125 (5H) for AIM-1 and FMK-1 (gyro induction compass).

Connection box of FMK-1 (6H).

Through circuit breaker A3C-5 (34M):

Indicator YT-6H (36M) of aileron trim tab via switch (100M).

Pilot lamp CMH-51 (38M) of neutral position of stabilizer trim tab effect mechanism.

Trim tab effect mechanism MP-100M (37M) via button MK (35M).

Busbar No.3

Connected to busbar No.3 are:

Through circuit breaker A3C-25 (9C):

Landing light change-over switch MHH-45 (10C) via fuse CH-5 (53C).

Landing light MCB-45 (11C) via relay PN-2 (8C) or taxiing light 0P-100 (39C) depending on position of change-over switch (10C).

Through circuit breaker A3C-5 (9H):

Through firing button 204K (10H) of cannons and bombing armament to selector switch of unit No.7 (38H) for control of sight ACN-5H and on to cut-in relay MP-1 (11H) of cannons and camera guns.

Bomb release relay PN-2 (8E).

Rocket firing relay PN-3 (54H).

Through circuit breaker A3C-10 (12H):

Camera mount controller of CH-45 (15H).

Timer BM-2 (13H).

Through circuit breaker A3C-10 (16H):

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Electric trigger (25N) of port wing cannon with contacts 7-8 of firing relay (11N) closed.

Ammunition rounds counter 3-M-005 (19N) of port cannon.

"Ready-to-fire" signal relay PH-2 (22N) of port cannon.

Electrically operated pneumatic valve 3K-48 (31N) when button (28N) of port cannon reloading is depressed.

Through circuit breaker A3C-10 (17N):

Electric trigger (26N) of fuselage cannon with contacts 9-10 of firing relay (11N) closed.

Ammunition rounds counter 3-M-005 (20N) of fuselage cannon.

"Ready-to-fire" signal relay PH-2 (23N) of fuselage cannon.

Electrically operated pneumatic valve 3K-48 (32N) with fuselage cannon reloading button (29N) depressed.

Through circuit breaker A3C-10 (18N):

Electric trigger (27N) of starboard wing cannon with contacts 11-12 of firing relay (11N) closed.

Ammunition rounds counter 3-M-005 (21N) of starboard cannon.

"Ready-to-fire" signal relay PH-2 (24N) of starboard cannon.

Electrically operated pneumatic valve 3K-48 (33N) with starboard cannon reloading button (30N) depressed.

Through circuit breaker A3C-20 (42N):

Filter 4-14A(2N) with contacts 8-7, 11-12 of relay MP-1 (45N) closed.

Heating of sight head (4N) and zero gyroscope (36N) of sight ACN-5HB3.

Circuit breaker A3C-10 (1N) from which voltage is supplied to:

units of automatic sight ACN-5HB3, voltage stabilizer (3N) sight head (4N), elevation gear (6N), distribution box (6N),

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computer (8N), electron relay (35N), zero gyroscope (36N), amplifier (37N), sight control desk (38N), damping button (39N) and potentiometer (41N) of manual range input.

Through circuit breaker A3C-10 (52N):

Cut-in relay PH-3(54N) of rocket armament C-5.

Control unit NY-2 (57N).

Switch NHH-45 (53N).

Signal board C-5 (56N).

Four units C-5 (47N, 48N, 58N and 59N).

Busbar No.4

Connected to busbar No.4 are:

Through circuit breaker A3C-10 (66):

Electromagnets of starboard and port bomb carriers BДЗ-56(1B and 2B).

Two green bomb suspension lamps CMH-51 (3B and 4B) which come out at bomb release.

Through circuit breaker A3C-10 (9E):

ARMED-SAFE bomb release mechanisms mounted in bomb carriers (1B and 2B), with tactical bomb release switch (7B) ON.

Red lamp CMH-51(5B) indicating setting of bombs to ARMED.

Through circuit breaker A3C-10(10E):

Two limit switches KB-6A(12B) and (13B) for interlocking simultaneous jettison of drop tanks.

Electromagnets (emergency windings) of bomb carriers (1B) and (2B) when button (11B) of emergency jettisoning of bombs or tanks is depressed.

Electromagnets of carrier locks of racks C-5 (49N, 50N) with button of emergency jettisoning of racks C-5 (51N) depressed.

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Through circuit breaker A3C-10 (5T):

Heat of clock AXX (1T).

Heat of air speed tube ПБД-4 (6T);

Through circuit breaker A3C-5 (12C):

Limit switches BK-44 of extension and retraction of landing gear left strut (13C) and (14C), extension and retraction of landing gear nose strut (15C) and (16C), extension and retraction of landing gear right strut (17C) and (18C). When landing gear struts are retracted limit switches (13C), (15C) and (17C) out in three lamps XC-39(21C, 22C and 23C) of external signalling and three lamps on flight and landing control board HHC-2 (20C). When landing gear struts are retracted limit switches (14C, 16C and 18C) also switch on three lamps on flight and landing control board HHC-2.

Air brakes extension electromagnetic cock PA-13/4 (46M) with switch (43M) on throttle control lever ON or button 204K (44M) on aircraft control stick depressed, with normally closed contacts 1-2, 4-5, 7-8 of relay TKE-53HД (103M) which effects interlocking of air brakes extension when stabilizer is controlled by electric actuator AHC-4.

Air brakes extension limit switch BK-2-140B-1 (19C) which, with air brakes extended, makes circuit of pilot lamp on flight and landing control board (20C).

Winding of rocket fire interlock relay PH-2 (55M) via limit switch BK-44 (16C) with nose strut retracted.

Warning lamp CЛH-51 (39M) of pressure drop in main and booster hydraulic systems which comes on with limit switches BK2-140B-1 (39M and 42M) ON.

Switch of position lights (25C), red position light BAHO-45(26C) of port wing, green position light BAHO-45 (27C) of starboard wing, white tail light XC-39 (28C) and two resistors MO-10-5 ohms (3C) and (4C) for changing brightness of position lights.

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Pilot lamps of flap landing position one of which, CM-30 (49C), is located on flaps control board and the other on board HHC-2 (20C).

Through circuit breaker A3C-5 (29C):

Electromagnetic valve PA-74M/5 (52M) of stabilizer booster via switch 88K (51M).

Electromagnetic valve PA-74/3 (48M) of aileron control booster, with switch 88K (47M) ON.

Through circuit breaker A3C-5 (42C):

Four signal flares 9KCP-46: yellow (35C), green (36C), red (37C) and white (38C) when switch B-45 (30C) is ON and signal flare buttons are depressed: (31C) for yellow, (22C) for green, (33C) for red, and (34C) for white flares.

Two ultraviolet lights APYΦOM-45: (47C) - left front light, (45C) - right light with rheostat PYΦO-45(46C) for left front light and (44C) for right light.

Receptacle 47K (43C) for plugging in of portable lamp.

Through circuit breaker A3C-5 (53M):

Landing gear extension electromagnetic valve PA-46/3 (55M) via switch HHH-45 (54M).

Drag chute pull-out electric valve 9K-48 (57M) with button 204K (56M) depressed.

Drag chute jettison electric valve 9K-48 (59M) with button 204K (58M) depressed.

Flaps extension and retraction units.

Flaps extension and retraction electromagnetic valve PA-46/2 (67M) via three microswitches KB-6-2, namely: (60M) for retraction of flaps, (63M) and (65M) for extension of flaps, via microswitch KB-6A (66M) of 15 deg. flap extension and via two limit switches BK-2-120B-1 of flaps UP position (61M - for port and 62M - for starboard flaps).

Two pilot lamps, namely: CM-30 (48C) for flaps UP position and CM-30 (50C) for flaps TAKE-OFF position.

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Through A3C-5 (109M) - pilot lamp APY-2A (78M) of take-off and landing position with check button (117M).

Variable ratio automatic boost control unit APY-2A (104M), mechanism APY-2A (105M) computing unit APY-2A (108M), position indicator change-over switch (106M) of APY-2 manual and automatic control, and switch (107M) of APY-2A manual control.

Bus bar No.5

Connected to busbar No.5 are:

Through circuit breaker A3P-15 (12M):

Booster pump ПНВ-2 (14M) of 2nd kerosene tank via filter Ф-14А (13M).

Pump operation pilot lamp СЛН-51 (2K) of second tank via contacts of pump operation warning mechanism СД-3 (1K).

Through circuit breaker A3P-10 (15M):

Booster pump ПНВ-1 (17M) of third kerosene tank via filter Ф-14А (16M).

Through circuit breaker A3P-10 (98M):

Booster pump ПНВ-1 (18M) of fourth kerosene tank via filter Ф-14А (97M).

Units not connected to aircraft mains:

Tachometer transmitter ДТ-3 (23K) of port engine.

Tachometer transmitter ДТ-3 (24K) of starboard engine.

Tachometer indicator 2ТБ-15-1 (22K).

Thermocouples (27K) of port engine.

Thermocouples (29K) of starboard engine.

Thermocouple block (26K) of port engine.

Thermocouple block (28K) of starboard engine.

Indicator 2ТБ-411 (25K) of thermocouples.

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Sources of Alternating Current

Four inverters: ИО-750 (2P), ИО-750(17P), ИТ-125 (5H) and ИАГ-10П (2H) serve as sources of alternating current.

Inverter ИО-750 (17P) supplies alternating current to automatic sight АСП-5НВ3 and radar ranging unit СРД-1М.

Inverter ИО-750 (2P) supplies alternating current to units of stations РСМВ-4, МРН-48П, СРО, radio compass АРК-5 and thyatron interrupter ИТ-51Д (17K) (from series 8-51-ИТ-51М).

Inverter ИАГ-10П (2H) supplies alternating current to gyro horizon АГВ-1 (3H) on emergency duty (if inverter ИТ-125 (5H) fails and А3С-5 (1H) is closed).

Inverter ИТ-125 (5H) supplies alternating current to units of gyro induction compass ГВК-1 and gyro horizon АГВ-1 on normal duty.

When inverter ИО-750 (2P) fails to operate, the stations can be supplied with alternating current from the other inverter ИО-750 (17P), for which purpose it is necessary to turn on switch 87K (16P) marked RADIO EMERGENCY SUPPLY, АРК, МРН, СРО, FLOWMETER (АВАР. ПИТ. РАДИО, АРК, МРН, СРО, РАСХОДОМЕР) and mounted on the vertical part of the starboard console. In this case automatic sights АСП-5НВ3 and СРД-1М become disconnected.

Note: The aircraft may be equipped with inverters, type ИО-750А, instead of ИО-750 type.

5. Power Supply Unit

The power supply system consists of two starter-generators ТСТ-СТ-6000А (69) and (73), battery 12САМ-28 (19) and units ensuring parallel and trouble-free operation and control of power supplies as well as their protection and blocking.

Each starter-generator ТСТ-СТ-6000А complete with starting and regulating equipment is designed for starting the

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engine with subsequent operation as generator to supply electric power to the mains loads.

The starter-generator is a D.C. six-pole electric machine with three communicating poles; it is coupled to the engine through two-stage reduction gear which automatically changes the reduction ratio with the change of operating conditions of the starter-generator.

The starter-generator is cooled by oncoming air flow and additionally by the fan mounted inside the generator body.

When the starter-generator is used as a starter, it operates in the 1st and 2nd starting stages with compound excitation and in the 3rd stage with series excitation. In 1st stage it operates with series-connected additional resistance while in 2nd stage the starter-generator operates with additional resistance disconnected. 3rd stage is operation of the starter-generator at higher r.p.m., after tripping of 4th microswitch ABN-1BE in HNC-6000E.

With a voltage of 21 V across the starter terminals and compound excitation, the speed of the starter-generator is not less than 1400 r.p.m. and current drawn not more than 260 A.

With a voltage of 21 V across the starter terminals and series excitation, the speed of the starter-generator is not less than 2400 r.p.m. and current drawn not more than 260 A.

When used as generator, the starter-generator operates with parallel excitation.

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Specifications of Generator

Rated power at 30 V	6000 W
Rated voltage	28.5 V
Rated load current	200 A
Operating speed range	4000 - 9000 r.p.m.
Maximum one-minute current (within 5000 - 8000 r.p.m.)	300 A
Maximum allowable load current without ventilation for 30 min.....	60 A
Maximum ten-second current (within 6000 - 8000 r.p.m.)	400 A

Brushes, grade MTC-7, size 7.2x17.5x25 mm.

The generators are connected to the aircraft mains through two switches 2B-45 (189) and (199). Then the generators are brought on the mains automatically with the aid of two differential relays DMP-400A (103) and (113). In this case the generator voltage should be 0.3 - 0.7 V above the mains voltage.

The generator becomes disconnected from the mains at the mains-to-generator reverse current of 15 to 35 A.

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When one of the generators fails to operate all loads may be fed from one generator, (total power drawn by all simultaneously operating electric loads being less than 6000 W).

Relay ПН-2 (283) serves for disconnection of the generators when the ground battery is used.

Differential relays ДМР-400А are intended for automatic connection and disconnection of the generators.

ДМР-400А comprises three main components:

- (1) Differential control relay.
- (2) Double-break contactor of straight travel type.
- (3) Auxiliary two-contact cut-in relay ПНА-2А with normally opened contacts.

Specifications of Relay ДМР-400А

Rated voltage 28 V
 Rated current through contactor contact ... 400 A
 Difference between voltages of generator
 and mains at which generator is brought
 on mains -0.3 to 0.7 V
 Cut-out reverse current 15 to 35 A
 Pick-up voltage of contactor and relay
 at +20°C in hot state not more than 20 V

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Drop-out voltage of contactor and relay

at +20°C in hot state not more than 5 V

Switch (183) and differential minimum relay (109) are intended for the port generator, switch (193) and differential minimum relay (113) for the starboard generator.

When the switch (183) is closed, the plus of the port generator (63) is supplied to the differential relay (109) which operates and brings the generator on the mains if its voltage exceeds the battery voltage, and removes it from the mains if the generator voltage is below the battery voltage at reverse current of 15 - 35 A.

In bringing the generator on the mains, the differential relay simultaneously ensures the operation of relay ПН-2 (6C) which cuts out red pilot lamp СЛН-51 (1C) mounted on the instrument panel and marked PORT GENERATOR OFF (ЛЕВЫЙ ГЕНЕРАТОР ВЫКЛЮЧЕН).

The starboard generator (73) is brought on the mains in a similar way. When it is connected, relay ПН-2 (7C) operates and cuts out red pilot lamp СЛН-51 (2C) mounted also on the instrument panel and marked STARBOARD GENERATOR OFF (ПРАВЫЙ ГЕНЕРАТОР ВЫКЛЮЧЕН). When the generators are removed from the mains, lamps (1C) and (2C) come on.

Ammeter shunts (223) and (233) are connected to receptacles 48K (243) and (253) to measure the current of the port and starboard generators.

Two voltage regulators P-27 (123) and (133) are used to maintain equal voltages across the terminals of the generators when changes in load, and/or speed of the engines take place or when the engines differ from each other in speed.

Specifications of Voltage Regulator P-27

Rated voltage 28.5 V
 Maximum power dissipated in carbon pile 85 W

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Voltage difference when r.p.m. of generator
are changed within operating range and
load is changed from zero to rated value 2.7 v
Limits of voltage adjustment by regulator
rheostat (from initial position) +2 v to
-2.5 v

Regulator P-27 incorporates:

- (1) Regulator itself with plate. It consists of electro-magnet with armature and carbon pile enclosed in finned cooler.
- (2) Stabilizing resistor.
- (3) Temperature compensating resistor.
- (4) Shock absorbing panel, "port" or "starboard".
- (5) External resistor BC-25E for readjustment of regulated voltage.

Regulator P-27 in conjunction with the plate is an independent unit which is mounted on the "port" or "starboard" panel and can be easily removed and replaced.

External resistor BC-25E being part of the P-27 set is removed from the regulator and installed at the place convenient for regulation.

The BC-25E external resistance of starboard generator regulator P-27 (139) is mounted on the starboard section of frame 14.

The BC-25E of port generator regulator P-27 (129) is mounted on the port section of frame 13.

The regulator carbon pile is placed in the circuit of the generator exciting shunt winding and changes its resistance in inverse proportion to the pressure exerted by the electromagnet armature spring.

The electromagnet incorporates three windings: equalizing (for parallel operation), compensating, and operating. An increase of pile resistance causes a decrease of current in

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the exciting shunt winding of the generator, thus a decrease of voltage across it, and vice versa.

The equalizing windings of the voltage regulators (129) and (139) are intended to equalize voltages of the starboard and port generators and, thereby, to ensure their parallel operation. They are connected in series and in accordance with ballast resistors (89) and (99) and windings of stabilizing transformers TC-9AM of the port and starboard generators.

For example, an increase of load in the port generator causes an increase of current passing through the generator's ballast resistor and voltage drop in the ballast resistor. As a result, voltage difference between ballast resistors takes place which causes current flow in the equalizing windings of the regulators. Magnetic flux set up by current in the winding causes a decrease of pressure on the carbon pile of the port generator's voltage regulator and an increase of pressure on the carbon pile of the starboard generator's voltage regulator. A decrease of pressure on the pile causes an increase of its resistance, a decrease of exciting current and voltage of the port generator, while an increase of pressure on the pile causes a decrease of its resistance, an increase of current in the exciting winding and an increase of voltage of the starboard generator to the value of the port generator voltage.

To reduce interference of the generators with radio reception six capacitors KBM-31(169) and (179) are installed: three capacitors for the port generator and three capacitors for the starboard generator.

To measure voltage produced by the generators two receptacles 48K are mounted, (263) for the port generator and (273) for the starboard generator.

Aircraft battery 12CAM-28 (19) is cut in the aircraft mains and cut out with the aid of switch (59) through con-

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tactor KM-200Д (23), through heavy current fuses TH-400 (293) and TH-200 (203) and (219).

The aircraft is provided with a receptacle (33) to connect the ground power supply which is brought on the aircraft mains by relay box PNA-200A (43) with the help of a switch (59).

When bringing the ground power supply on the mains, the relay box (43), ensures:

- disconnection of the aircraft battery from the mains;
- protection against connection of reversed polarity power supply to the mains;
- cut-out of the generators with the help of relay PH-2 (289);
- cut-in of radar ranging unit CPД-1M and sight ACN-SHB3 through relay MP-1 (45H).

To monitor mains voltage, voltmeter B-1 (303) connected through fuse CH-5 (373) is used.

Layout of Power Supply Units

The assemblies of the power supply system are installed in the fuselage nose section at the following places:

Storage battery 12CAM-28 in the upper nose equipment bay between frames 2 and 3.

Starter-generators PCP-CT-6000A in the upper front part of each engine.

Ground supply cut-in receptacle on the fuselage port side in the bottom between frames 18 and 19.

Relay box PNA-200A (43) on the port side bottom between frames 12 and 13.

Contactors KM-200Д (23) to cut in the storage battery in the upper nose equipment bay between frames 3 and 4 (or on a horizontal member).

Heavy current fuse TH-400, in the upper nose bay on the port side between frames 2 and 3.

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Voltage regulator P-27 (129), differential relay DMP-400A (109), ammeter shunt A-46 (223), heavy current fuse TH-200 (203), three capacitors KEM-31 (163), out-in contactor KM-50Д (363) of the pump of the first kerosene tank, receptacle 48K (243) to measure the port generator current, receptacle 48K (263) to measure the port generator voltage, receptacle 48K (253) to measure the starboard generator current, receptacle 48K (273) to measure the starboard generator voltage, circuit breaker ASC-30 (343), circuit breaker ASC-10 (31P), time-lag fuse WH-75 (32P), circuit breaker ASC-40 (353), circuit breaker ASC-10 (88M) and three relays PH-2 (19E, 289, 6C), stabilizing transformer TC-9AM (403) - on the port side top between frames 12 and 14. Ballast resistor EC-6000 (83) is mounted on the port side top between frames 14 and 15.

Voltage regulator P-27 (133), differential relay DMP-400A (119), ammeter shunt A-46 (239), heavy current fuse TH-200 (219), three capacitors KEM-31 (179), circuit breaker ASC-30 (319), circuit breaker ASC-30 (31M), circuit breaker ASC-25 (329), time-lag fuse WH-75 (30P), four relays PH-2 (7C, 92M, 94M, 18E) stabilizing transformer TC-9AM (419), circuit breaker ASC-40 (339), circuit breaker ASC-30 (101M), fuse WH-10 (162M), ASC-15 (102M), ballast resistor EC-6000 (93) - on the starboard side top between frames 12 and 15.

6. Engine Starting

The engines are started by starter-generators PCP-CT-6000A (63 and 79). The engines may be started both from the airborne battery and from the ground one.

The aircraft is provided with a blocking system which precludes simultaneous starting of both engines.

The starting system of the port engine includes: starting button 204K (3E), panel HJ-3 (14E) to control operating conditions, ignition switch 88K (12E), blocking relay PH-2

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(19E) of the starting button, starting pump ННР-10-9М (71М), electromagnetic valve (6М) of the fuel pump, electromagnet (69М) of the starboard engine's air by-pass band, starting coil unit КН-21-Б1 (6Е) with ignition plugs СД-96 (8Е).

Starting panel НКС-6000Е (1М), ignition pilot lamps СМЛ-51 (2Е) of the port engine.

To start the port engine on the ground, it is necessary to close circuit breakers АЗС-25 (1Е) and АЗС-5 (11М, 19М, 5М), set the throttle control lever to the LOW SPEED (МАЛЫЙ ПАЗ) position and to depress the button (3Е).

With the АЗС-5 (11М) cut in, the plus of busbar 1 is supplied to: starting buttons 204К (3Е) and (4Е) of the port and starboard engines through the normally closed contacts of the second microswitch of the timer of НКС-6000Е (1М) starting panel and to the normally open contact of microswitch No.1 of the НКС-6000Е timer.

With the АЗС-25 (1Е) cut in, the plus of busbar 1 is delivered to two ignition switches 88К (12Е) and (15Е), to terminals CONTROL (КОНТРОЛЬ) of ignition warning lamps СМЛ-51 (2Е) and (5Е) and to the moving contacts of relays И, К, Л of the starting panel.

With the button (3Е) depressed, the winding of relay Л of the starting panel becomes cut in through contacts 1-2 of relay П and the normally closed contacts (1-2) of relay ПН-2 (19Е) which precludes repeated starting of the running engine. As a result, relay Л operates and through its own contacts 8-9 cuts in the electromotor, while via the normally closed contacts of the first microswitch of the timer, it supplies positive voltage to the winding of relay ПН-8Е and to microswitches 2, 3 and 4 of the timer.

Relay ПН-8Е of the timer operates, closes the contactor, and thereby blocks the first microswitch.

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Rotation generated by the electromotor is transmitted through the worm reductor to the four cams which turn and close the four microswitches in succession.

The turn of the first cam brings into action the first microswitch which ensures power supply to the electromotor of the timer immediately from circuit breaker АЗС-5 (11М) in which case the starting button is by-passed.

Turning of the second cam brings into action the second microswitch and supplies the positive potential simultaneously to the winding of the main contactor, to the winding of relay И, to the switch COLD CRANKING (ХОЛОДНАЯ ПРОКРУТКА) of the control panel (14Е) and to the electromagnet of the air by-pass band (69М) of the starboard engine. The main contactor operates and cuts in the port starter-generator through the killing resistor.

When operating, relay К disconnects the shunt winding of the starter-generator (69) from voltage regulator Р-27 (129) and connects it to the mains through the АЗС-25 (1Е), through normally closed contacts 7-6 and 5-8 of relay Л.

The throttle lever control in the LOW SPEED position closes the cold cranking switch and cuts in the winding of relay К through ignition switch 88К (12Е). Relay К operates and, through its own contacts 7-3, cuts in the starting pump ННР-10-9М (71М); through contacts 8-2 it cuts in the electromagnetic valve (6М) of the starting pump, starting coil unit КН-21-Б1 (6Е) with ignition plugs СД-96 (8Е) and red pilot lamp СМЛ-51 marked LEFT (ЛЕВЫЙ) and AFTER AIRSTART, SWITCH OFF IGNITION (ЗАПЯСЬ В ВОЗДУХЕ ПРОИЗВЕЛ, ВАЖИТАНИЕ ВЫКЛЮЧИ) and installed on the right side of the shock-mounted portion of the instrument panel.

The turn of the third cam brings into action the third microswitch which supplies the positive potential to the winding of the auxiliary contactor.

The contactor operates and shunts the killing resistor.

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Turning of the third cam brings into operation the fourth microswitch through contacts of which voltage is supplied to the winding of relay J. Relay J operates and disconnects the shunt winding of the starter-generator (33), as a result, the starter-generator starts to operate under series excitation conditions.

To perform an airstart of the port engine, ignition switch 88K (12E) should be set to the position AIRBORNE IGNITION (ЗАЖИГАНИЕ В ВОЗДУХЕ) in which case the winding of relay K is cut in. Relay K operates and cuts in electromotor MV-102A of starting pump ПНП-10-9M (71M), starting coil unit КН-21-Б1 (6E) with ignition plugs СД-96 (8E), the electromagnetic valve of the starting pump (6M) and pilot lamp СЛН-51 (2E).

The starboard engine is started in a similar manner.

The starting system of the starboard engine includes: starting button 204K (4E), panel ПУ-3 (13E) to control operating conditions, ignition switch 88K (15E), blocking relay ПН-2 (18E) of the starting button, starting pump ПНП-10-9M (71M), the electromagnetic valve (5M) of the starting pump, the electromagnet (70M) of the air bypass band of the port engine, starting coil unit КН-21-Б1 (7E) with ignition plugs СД-96 (9E), ignition warning lamp СЛН-51 (5E) of the starboard engine.

Circuit breakers А3С-25 (1E) and А3С-5 (11M), starting panel (1M), and starting pump ПНП-10-9M (71M) are used in starting either of the engines.

7. Afterburning

Afterburning is accomplished by the pilot by pulling the engine controls beyond the maximum rating stop.

Let us consider, as an example, afterburning of the port engine.

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The afterburning system of the port engine incorporates:

Ratings control panel (14E).

Relays Б, Г, Е, И, М, О of afterburner control unit КАФ-2 (3M).

Afterburner fuel minimum pressure warning mechanism АСД-2 (11K).

Afterburner out-in blocking limit switch БК-2-140Б-1 (32M).

Electromagnetic valve of afterburner fuel pump HP-11A (10M).

Contact of the afterburning needle of pump HP-11A (82M).

Contact of the hydraulic decelerator of pump HP-10A (8M).

Afterburner ignition coil КНМ-1А (16E) with ignition plug СН-02 (10E).

Two electromagnetic cocks ГА-21 (74M), (75M).

Afterburner green pilot lamp (2M).

Pressure warning mechanism СД-3 (6K) of the first kerosene tank.

Pump operation red pilot lamp (12K) of the first tank.

The ratings control panel carries:

Starting limit switch 3.

Cold cranking limit switch ХП.

Maximum rating limit switch М.

Afterburning limit switch Ф.

Limit switch to set limit oil pressure warning mechanism to two limits.

Switch to cut out the starting coil unit with ignition plugs and the electromagnetic fuel valve when the engine is prepared for storage.

The cold cranking limit switch gets closed when the throttle control levers are pulled through 4° from the STOP (СТОП) position.

The engine starting limit switch gets closed when the throttle control lever is pulled beyond the low speed stop.

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The limit switches of maximum and afterburning ratings are cut in when the throttle control lever is moved beyond respective stops.

The nozzle eyelids may have three positions: fully opened, half-closed and neutral. The neutral position corresponds to nominal rating, fully opened, to afterburning rating and starting, half-closed, to maximum rating.

The afterburner units get power supply from busbar No.1 via two circuit breakers A3C-5 (86M) and A3C-5 (87M) and from the port generator busbar via A3C-10 (88M).

When the engine control lever is pulled from STOP (CTON) position to NOMINAL (NOMINAL) stop, the positive potential is simultaneously supplied through A3C-10 (88M) to the second terminal of PA-21 (74M) via contacts 2-1 of relay E and to the first terminal of PA-21 (75M) via normally closed contacts 5-4 of relay I and relay E, starting limit switch of the engine ratings control panel and on through contacts 3-2 of the relay (92 M).

Valves PA-21 (74M) and (75M), having started to operate, deliver hydraulic fluid to the nozzle control cylinder and set the nozzle to the afterburning position.

When the A3C-5 (86M) is closed the positive potential is supplied to:

Contact of hydraulic decelerator of HP-10A (8M) through normally closed contacts 5-4 of relay M and relay FI-2 (92M).

Afterburner fuel minimum pressure warning mechanism (11 K).

Winding of relay O through normally closed contacts 2-1 of relay E.

Relay O cuts out the fuel valve of the afterburner manifold when pressure is absent in the nozzle eyelids cylinders. The time delay (0.3 - 0.5 sec.) in operation of relay O is necessary to provide the possibility for a pressure increase in the nozzle eyelids cylinders.

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When the A3C-5 (5K) is cut in, the positive potential is supplied to pressure warning mechanism CA-3 (6K) of the first tank and to contact 2 of relay M.

The contact of the hydraulic decelerator (8M) gets closed at 10,500 r.p.m. of the engine and the positive potential is supplied through it to maximum rating switch M and to afterburner switch @ of the ratings control panel (14E).

When the engine control levers are set to the AFTER-BURNING (OOPCAE) position, the afterburner switch of the ratings control panel via normally closed contacts 5-4 of relay M cuts in the electromagnetic valve of afterburner pump HP-11A (10M), winding of relay I and also delivers the plus of voltage to afterburner cut-in blocking limit switch BK-2-140B1 (32M).

The electromagnetic valve of afterburner pump HP-11A operates and supplies fuel to the afterburners, in this case the contacts of the afterburner fuel minimum pressure warning mechanism (11K) get closed and the winding of relay E gets energized.

Relays I and E operate and disconnect the plus of voltage from the second terminal of PA-21 (75M); from A3C-10 (88M) the plus of voltage is delivered through contacts 5-6 of relay I and through contacts 8-9 of relay E to the first terminal of valve PA-21 (75M); from A3C-5 (86M) - to afterburner ignition coil KHM-1A (16E) through contacts 2-3 of relay E, contacts 9-8 of relay I and normally closed contacts 4-5 of relay E; through contacts 2-3 of relay I to the afterburning pilot lamp (2M) mounted in lamp register T-6 on the right-hand panel of the frame.

The PA-21 hydraulic unit operates, delivers the hydraulic fluid to the nozzle eyelids cylinders, and sets them into the AFTERBURNING position. In this case the positive potential is supplied to the first terminal of the PA-21 valve (74M).

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The contact of the afterburning needle of pump HP-11A (82M) at the maximum pressure of afterburner fuel gets closed and cuts in the winding of relay E. Relay E operates and breaks the ignition circuit.

Afterburning ceases when the A3C-5 (86M) is opened, when the hydraulic system fails to operate, when fuel pressure in the first kerosene tank is less than 0.3 kg/sq.cm., when excess pressure in the afterburner fuel manifold is less than 0.2 kg/sq.cm.

In the event of hydraulic system failure, afterburner cut-in blocking limit switch BK-2-140B (32M) closes the contacts and cuts in the winding of relay M.

Relay M operates, de-energizes the electromagnetic valve of afterburner pump HP-11A (10M) and the winding of relay F. The contacts of relay F return to the initial position and cut out the first winding of the PA-21 valve (75M) and afterburner ignition coil (16E).

After disconnection of the electromagnetic valve of the afterburner pump, the pressure of afterburner fuel drops and the afterburner fuel minimum pressure warning mechanism (11K) opens the contact and de-energizes the winding of relay E.

The contacts of relay E return to the initial position, cut out the first winding of the PA-21 (75M) unit and connect the plus of power supply to the second winding.

If fuel pressure in the first kerosene tank is less than 0.3 kg/sq.cm., pressure warning mechanism CJ-3 (6K) closes the contacts and delivers electric power from the A3C-5 (5K) to the winding of relay M. Relay M operates, opens the circuits running from the A3C-5 (86M) to the ratings control panel (14E) and cuts in the red pilot lamp (12K) labelled 1st TANK (1-WE BAK).

The thrust afterburning of the starboard engine is accomplished in a similar manner.

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The afterburning system of the starboard engine incorporates:

Ratings control panel (13E).

Relays A, B, D, E, K, M and H of afterburner control unit KA-2 (3M).

Afterburner fuel minimum pressure warning mechanism (33K).

Afterburner cut-in blocking limit switch BK-2-140B-1 (83M).

Electromagnetic valve of afterburner fuel pump HP-11A (9M).

Contact of the afterburning needle of pump HP-11A (81M).

Contact of the hydraulic decelerator of pump HP-10A (7M).

Afterburner ignition coil KIM-1A (17E) with ignition plug CH-02 (11E).

Two electromagnetic valves PA-21 (84M), (85M).

Afterburner red pilot lamp (4M).

Pressure warning mechanism CJ-3 (6K) of the first kerosene tank.

Pump operation red pilot lamp (12K) of the first tank.

At high altitudes the speed of the engine is high even if the engine control lever is set to LOW SPEED. To prevent the possible opening of the jet nozzle eyelids for the AFTERBURNING position under the above conditions, provision is made to block the opening of the eyelids along the air by-pass band with the help of two relays PI-2 (92M, 94M).

In these conditions, when the engine speed is over 9700 - 10,000 r.p.m., the by-pass band is closed, the PI-2 winding is de-energized and the first winding of valve PA-21 (75M) (through closed contacts of starting limit switch) in panel IV-8 of port engine will not be supplied. Valve PA-21 (85M) of the starboard engine also will not be supplied.

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Note: To check the afterburning electric circuits with engines not running, the front side of KAQ-2 afterburner carries change-over switches which are operated by turning the slotted heads with a screw-driver.

To operate the system at maximum rating, the throttle control lever is set to the position of the MAXIMUM (МАКСИМУМ) stop. This closes the contacts of limit switch M in the HY-3 of the starboard and port engines through which voltage is delivered to the windings of relay J (for port engine) and relay K (for starboard engine) which operate and change over power supply to the TA-21 (74M) for port engine and (84M) for starboard engine from the second winding to the first winding which causes the nozzle eyelids to close for the MAXIMUM position.

8. Electric System of Controllable Stabilizer

A. General

The longitudinal control of the aircraft is carried out by the stabilizer which is controlled with the help of the hydraulic booster employing a non-reversible cycle; artificial feel on the control stick is effected by means of a spring feel mechanism in conjunction with the trim tab effect mechanism (See Fig.3).

In the event of booster failure (at pressure drop in hydraulic system), emergency electric control of the stabilizer is automatically started. The control is effected by ANC-4 electric actuator with the help of the electric follow-up system (See Fig.4). In this case the stabilizer is controlled through normal movements of the control stick.

The angle of the stabilizer in these conditions is changed at a constant rate which is less than the rate developed in case of booster employment.

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When the stabilizer is controlled with the help of the control stick (when either hydraulic booster or electric follow-up system operates). Aerodynamic effort on the control stick is simulated by the variable ratio boost control unit.

The variable ratio boost control unit (APV), without interference on the pilot's part (automatically), changes the gear ratio from the control stick to the stabilizer and spring feel mechanism, depending on the indicated speed and altitude of flight.

Regulation with reference to ram pressure is effected within the range of indicated speed from $V_{ind} = 480$ km/hr to $V_{ind} = 900$ km/hr. With increase of speed, an equal travel of the stick requires more effort on the stick and produces a lesser angle of stabilizer deflection; with decrease of speed, control is carried out in the reverse order.

Regulation (correction) with reference to altitude takes into account the change of stability and controllability of the aircraft at high Mach numbers and is effected over the range of altitudes from $H = 5000$ m. to $H = 10,000$ m. (at the same time as control with reference to speed).

With an increase of flight altitude, an equal travel of the stick requires less effort on the stick and produces a larger angle of stabilizer deflection; with a decrease of altitude, control is carried out in the reverse order.

At altitudes below 5000 m. the operation of the automatic system depends solely on ram pressure in which case at speeds over 900 km/hr constant values of gear ratio are maintained which correspond to maximum effort on the stick and minimum angles of stabilizer deflection (small arm).

At altitudes over 10,000 m. (irrespective of speed), also at speeds below $V_{ind} = 480$ km/hr (irrespective of altitude), values of gear ratio are maintained which correspond to minimum effort on the stick and to maximum angles of stabilizer deflection (large arm) which in turn corresponds to the take-off and landing position of the system.

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Operation of the APY is controlled with the aid of the indicator mounted in the upper part of the instrument panel.

When the boost control unit is set to the take-off or landing position, the green pilot lamp mounted on the instrument panel and marked LAMP IS NOT ON AT LANDING - CHANGE OVER TO APY MANUAL CONTROL (НА ПОСАДКЕ ЛАМПА НЕ ГОРИТ - ПЕРЕХОДИТ НА РУЧНОЕ УПРАВЛЕНИЕ АРУ).

In the event of failure of the computing unit of the automatic system, the pilot may operate the APY unit manually, by switching on its electromotor.

To pass over to the manual control of the APY unit, the APY selector switch on the port console desk should be set to the MANUAL (РУЧН.) position. The APY unit is operated by setting the control switch on the port console to LARGE ARM (БОЛЬШОЕ РУЧНО) or SMALL ARM (МАЛОЕ РУЧНО).

The employment of the controllable stabilizer together with the automatic regulation system considerably widens manoeuvre possibilities of the aircraft and ensures almost uniform flying technique.

B. Set of Electric System of Controllable Stabilizer and Layout of Units

(1) Unit APY-2A (104M) ensures:

(a) control of gear ratios from the control stick to the stabilizer and simultaneously to the spring feel mechanism.

The regulation law fulfilled by the automatic system of the APY-2A is the function of ram pressure and flight altitude;

(b) uniform flying technique by increasing the load on the stick and lengthening the stick travel per one degree of stabilizer deflection with the increase of indicat-

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ed speed and decrease of altitude within the range of H = 5000 m. to H = 10,000 m.

At ram pressures which correspond to take-off, landing and flying on a circuit course, the automatic system, irrespective of altitude, is in the take-off and landing position, the APY-2A automatic system operates independently, without the pilot's interference, except for the cases when the computing unit taking the ram pressure fails to operate;

(c) control of the APY-2A position by aid of the indicator on the instrument panel.

Control unit APY-2A is located in the region of frames 26 to 28, in the upper part of the fuselage tail section.

Table 1
Components of Automatic System APY-2A

Nos	Type	Description	Purpose
1	2	3	4
1	МРД-106	Small-size rheostat transmitter of pressure	Sending signals to ram pressure automatic system
2	МРД-126	Small-size rheostat transmitter of rarefaction	Sending signals to altitude automatic system
3	РПС	Polarized relay	Summation of signals from МРД-106, МРД-126, and feed-back
4	РС-8	Power relay	Intermediate relay between РПС and РРТ-40

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1	2	3	4
5	PPT-40	Reversing and braking relay	Starting and tracking of electromotor MY-100AH
6	MY-100AH	Series reversible electromotor	Drive of actuating mechanism of APV-2A

(2) The computing unit (105M) is located in the cockpit behind the instrument panel and ensures the conversion of impact and static pressures into a respective potential which is the function of ram pressure and altitude $V = f(q, H)$, where:

V - mismatch voltage;
q - ram pressure;
H - altitude of flight.

Mismatch voltage causes the operation of the computing unit special relay PHC which connects the power circuit to the respective side of rotation of electromotor MY-100AH in control unit APV-2 and sets the control unit to an arm corresponding to ram pressure and altitude (See Fig. 6).

(3) Selector switch 88K (106M) of the APV-2A mechanism marked MANUAL (РУЧНОЕ), AUTOMATIC (АВТОМАТИЧЕСКОЕ) and mounted on the port console.

(4) Switch PH-45 (107M) of APV-2A manual control mounted on the port console.

(5) APV-2A position indicator (specially adjusted voltmeter B-1 (108M) on the instrument panel.

(6) Electric actuator MH-100M (37M) of the spring feel mechanism mounted in the fuselage tail section, top in the vicinity of frames 26 to 28.

(7) Electric actuator MYC-2 (113M) for electric control of the stabilizer (in absence of hydraulic pressure) from mismatch transmitter DP-5 (91M).

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(8) Mismatch transmitter DP-5 (91M) to operate electric actuator MYC-2 (113M) in case of pressure drop in the hydraulic system located on top between frames 26 and 27.

(9) Limit switches BK-2-140B-1 of cylinder switches (40M) and (118M) behind valve PA-74M/5 of the stabilizer booster located between frames 26 and 27 on top.

(10) Switch 88K (51M) to cut in and out the stabilizer booster located on the horizontal portion of the port console.

(11) Contactor KM-25Д (72M) to cut in electromotor of the MYC-2 and reversing clutches of the MYC-2 through the DP-5 in case of pressure drop in the booster system, mounted in the fuselage tail section.

(12) Circuit breakers:

(a) A3C-5 (34M) in supply circuits of electric actuator YT-6Д of aileron trim tab and trim tab effect electric actuator MH-100M (37M);

(b) A3C-30 (101M) in the right-hand power supply unit in the circuit of the electromotor of electric actuator MYC-2 (113M) and reversing electromagnetic clutches of the MYC-2 through transmitter DP-5 (91M);

(c) A3C-5 (109M) of the APV-2A operation control circuits;

(d) A3C-15 (102M) is mounted in the starboard power supply unit and feeds the computing unit (105M);

(e) A3C-5 (116M) on the starboard console in the circuit of limit switches (40M) and (118M) and contactor KM-25Д (72M).

C. Stabilizer Control Conditions

(1) Main hydromechanical control. This is a follow-up control of the stabilizer by aid of hydraulic booster BY-14M fed from the booster hydraulic system. Operating the control

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stick, the pilot shifts the valve of the hydraulic booster which causes the movement of the EV-14NC actuating rod and stabilizer deflection through bellcranks.

(2) Emergency hydromechanical control of the stabilizer. Booster EV-14NC in this case operates not from the booster system, but from the main hydraulic system.

The change from the main to emergency hydromechanical control is effected automatically, with the aid of the valve switch of the hydraulic system.

(3) Emergency electromechanical control of the stabilizer is a follow-up control by means of electric actuator ANC-4. Using the control stick, the pilot through the control system closes one of the limit switches in mismatch transmitter DP-5.

The change-over to this control condition is effected automatically by means of the KUSM valve and limit switches BK-3-140-P-1 (40M) and (118M) or by opening the switch of booster EV-14NC.

Under all the control conditions the APV-2A automatic system operates either automatically (if APV-2A computing unit is in good condition) or the pilot may use the APV-2A manual control by setting a required arm.

D. Electric Actuator ANC-4

(a) General

Electric actuator, type ANC-4, (Fig.8) is intended for emergency control of the stabilizer in case of pressure drop in the booster hydraulic system and serves as a power output of the electric follow-up system of relay-contact type.

Electric actuator ANC-4 consists of:

- (1) Electric actuator MVC-2.
- (2) Reductor which engages the ball convertor and hydraulic friction clutch.

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(b) Specifications

- (1) Supply voltage 27 V
- (2) Range of operating voltage 24.3 - 29.7 V
- (3) Current drawn:
 - (a) rated, not more than 12 A
 - (b) maximum, not more than 17 A
- (4) Load applied to rod in both directions:
 - (a) rated 680 kg
 - (b) maximum 1150 kg
 - (c) assisting 1700 kg
- (5) Speed of rod movement:
 - (a) at rated load, not less than 11.5 mm/sec.
 - (b) at maximum load, not less than 9 mm/sec.
 - (c) at maximum assisting load, not more than 18 mm/sec.
- (6) Rod travel:
 - (a) operating travel (restricted by limit switches) 116 mm
 - (b) maximum travel 123 mm
- (7) Load overcome by electric actuator before slipping of friction clutch, not less than 1200 kg
- (8) Load applied to rod and held by electric actuator before slipping of friction clutch (electromotor not operating) in both directions, not less than 2000 kg
- (9) Operating conditions of hydraulic clutch:
 - (a) operating fluid ANT-10
 - (b) operating pressure 60 - 210 kg/sq.cm.
 - (c) engagement of clutch at pressure drop of not less than 2 kg/sq.cm.

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- (d) disengagement of clutch at pressure increase, not more than 55 kg/sq.cm.
- (e) effort required to shift rod in both directions with clutch disengaged:
 - at a temperature of -60°C 100 kg
 - at a temperature of $+20^{\circ}\text{C}$ 75 kg
- (10) Clearances of rod:
 - (a) radial clearance (when rod is fully extended) measured from axis of ear with bearings, at alternating load of 5 kg, not more than 0.75 mm
 - (b) axial clearance, at alternating load of 80 kg, not more than 0.23 mm
- (11) Inertial run-out of rod in no load travel at rated supply voltage, not more than ... 0.9 mm
- (12) Operating conditions of actuator with counteracting load along rod. With hydraulic clutch engaged and counteracting load applied to rod from power drive, type MYC-2, actuator should operate under following conditions:
 - (a) extension and retraction of rod with counteracting load of 680 kg applied to rod. Number of cycles - 12
 - (b) extension and retraction of rod with counteracting load of 1150 kg applied to rod. Number of cycles - 1
(1 cycle is 6 switchings for extension and 6 switchings for retraction; in both cases to length of operating travel (116 mm), followed by 1-min. interval)

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Note: Operation in accordance with (a) and (b) in any sequence should be followed by complete cooling.

- (13) With hydraulic clutch disengaged, actuator permits for shift of rod from external mover on following intermittent duty:
 - (a) retraction of rod from length of 420 mm to length of 350 mm and extension of rod from length of 350 mm to length of 420 mm in 2 seconds. Number of cycles - 20;
 - (b) retraction of rod from length of 420 mm to length of 410 mm and extension of rod from length of 410 mm to length of 420 mm in 1 second. Number of cycles - 3560.

Operation in accordance with (a) and (b) in any sequence should be followed by complete cooling.

Note: Operating travel of rod implies difference in distance between axis of body and axis of rod ear when rod moves within the range of 344 to 460 mm.

- (14) Electric actuator is designed for operation under following conditions:
 - (a) relative humidity of ambient air up to 98 per cent;
 - (b) ambient temperature variation within $+60^{\circ}\text{C}$ to -60°C . Actuator may be operated for three minutes at a temperature of $+110^{\circ}\text{C}$.

(c) Principle of Operation
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The functional diagram of the electric actuator is shown in Fig.9.

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Electric actuator MYC-2 converts electrical control signals from transmitter DP-5 to reverse the rotary motion of the output shaft.

In absence of electric control signals the MYC-2 output shaft is shorted on the actuator body. Irrespective of control signals, a pressure drop in the booster hydraulic system switches on reversing electromotor A-160 which drives the MYC-2.

Electric actuator ANC-4 comes into action in case of failure of the main hydraulic unit of stabilizer control.

When pressure in the hydraulic system drops, the external cone moves under spring action until it engages, in the axial direction, the cone of the hydraulic friction clutch.

At this point rotation from electric actuator MYC-2 is transmitted through the hydraulic friction clutch and gear reductor to the ball converter which is linked to the stabilizer.

Electric actuator ANC-4 has three styles of operation:

(a) Free travel:

In this case the hydraulic friction clutch is disengaged, the actuator rod is freely moved by the stabilizer driving booster and the linear motion of the rod is converted in the ball converter into the rotary motion of the reductor gear pairs.

(b) Self-braking:

The hydraulic friction clutch is engaged and the control windings of the reversing clutches of MYC-2 electric actuator are de-energized. In this case the actuator rod holds the hinge moment of the stabilizer which may build up effort both for retraction and extension of the rod.

In this case electromotor A-160 is operating in the control system of the aircraft.

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(c) Drive:

The hydraulic friction clutch is engaged and at the same time one of the reversing clutches of the electric actuator is cut in. In this case the electric actuator over-coming or holding the hinge moment shifts the stabilizer.

Depending on the direction in which the stick is pulled by the pilot (i.e. depending on the mismatch sign) one of the two reversing clutches of MYC-2 electric actuator is cut in and the actuating rod moves either in the direction of retraction or in the direction of extension.

When the aircraft flies with the stabilizer booster operating (i.e. when the delivery line of the booster has high pressure which also disengages the conical friction clutch), ANC-4 electric actuator operates in conditions of free travel.

When pressure in the delivery line of the stabilizer booster drops (i.e. when pressure applied to the piston of the conical friction clutch also drops) and the control stick is immovable, the electric actuator operates in conditions of self-braking.

When pressure in the delivery line of the stabilizer booster drops (i.e. when the ANC-4 conical hydraulic clutch is cut in) and the control stick is pulled, the actuator operates in conditions of drive.

9. List of Electrical Connectors

Connect- or number	Type	Purpose	Place of installation
1	2	3	4
1	ИПТ-23	For passage through wall of pressurized cook- pit	Frame 4, port, top

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1	2	3	4
2	WPT-3	For passage through wall of pressurized cockpit	Frame 9, port, top
3	WPT-23	Same	Same
4	WPT-23	Same	Same
5	WPT-7	Same	Frame 9, starboard, top
6	WPT-23	Same	Same
7	WPT-13	Same	Cockpit floor. Frames 8-9, port
8	WPT-23	Same	Same
9	WPT-7	Same	Frame 4, starboard, top
10	WPT40NK16-NM2	Same	Cockpit floor. Frames 8-9, port
11	WPT40NK16-NM2	Same	Same
12	WPT40NK16-3M2	Same	Cockpit floor (inclined portion), frames 8-9, starboard
14	WPT-13	Same	Frame 4, starboard, top
15	WPT-23	Same	Cockpit floor. Frames 8-9, port
16	WPT-19	For port removable part of instrument panel	Cockpit

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1	2	3	4
18	WP-23	For starboard front electric board	Cockpit
19	WP-3	Same	Same
20	WP-23	For starboard rear electric board	Same
22	WP48NK26-WP2	For relay box and fuses. Relays: 5p, 4p, 21p, 44H. Fuses: 35p, 8p, 7p, 20p, 36p, 6p, 37p, 43H and 9K	Fuselage nose section starboard bottom, at frames 5A, 6
23	WP-13	For reloading board, button of parachute pull-out, jettison button and switch INNER-OUTER (ВНУТРИ-ДАЛЕЙШИЙ)	Cockpit
24	WP-7	For throttle control lever, button of radio station, switch of air-brakes, and range rheostat	Same
25	WP-23	For port electric board, ABC	Same
26	WP-23	For port electric board: switch, buttons, rheostat	Same

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1	2	3	4
28	WP-4	For port console: fire-warning lamp and button	Fuselage nose section starboard bottom, at frames 5A, 6
29	WP-23	For box of relays 35K, 22N, 23N, 24N, 11N	Same
30	WP-13	For control stick	Same
31	WP-7	For signal flare board	Same
32	WP-4	For resistor of position lights AHO	Same
34	For 4 ter- minals	For ground supply	Fuselage nose section
35	WP-19	For box of relays: 55N, 68M, 24C, 8C	Fuselage nose section
37	WP-7	For flap micro- switches 64M and 66M	Port wing
39	WP-7	For L.G. port strut	Same
42	WP-7	For detachment of port wing	Same
43	WP-23	For detachment of port wing	Port wing
44	WP-23	For detachment of starboard wing	Starboard wing
45	WP-4	Same	Same
46	WP-7	For L.G. star- board strut	Same

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1	2	3	4
47	For 4 ter- minals	For aircraft battery	Starboard wing
48	WP-7	For detachment of fuselage tail section	Fuselage tail, section frame 20A
49	WP-2	For inertia transmitter of starboard wheel brake releasing	Starboard wing
50	WP-2	For inertia transmitter of part wheel brake releasing	Port wing
56	WP-7	For detachment of fuselage tail section	Fuselage tail section, frame 20A
57	WP-23	Same	Same
58	WP-23	Same	Same
60	WP-19	For relay of lamp register 36K	Cockpit
61	WP-4	For electric actuator JT-6M of aileron trim tab	Port wing
62	WP-4	For sight (in place of block)	Cockpit, port
63	WP-18	For relays of port power supply unit: 19E, 289, 6C	Fuselage nose section
64	WP-19	For relays of starboard supply unit: 92M, 94M, 7C, 18E	Same

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1	2	3	4
66	MP-23	For box of relays 54H, 8B, 45H	Cockpit
67	MP-7	For instrument panel: pilot lamps 1c and 2c	Same
70	MP-4	For KB-6A of simultaneous drop	Port wing
72	MP-4	Same	Starboard wing
76	MP-13	For removal of universal carriers of rockets	Port wing
78	MP-9	For rockets	Same
80	MP-9	For rockets	Starboard wing
82	MP-13	For removal of universal carriers of rockets	Starboard wing
84	MP-3	For removal of door of 1st tank	Fuselage nose section
85	MP-9	For detachment of port wing	Port wing
86	MP-9	For detachment of starboard wing	Starboard wing
90	MP-2	For starboard electric board (rear)	Cockpit
91	MP-2	For inertia transmitter of starboard wheel brake releasing	Fuselage nose section
93	MP-23	For relay 103H, contactor KT-25A and fuse 174H	Fuselage tail section

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1	2	3	4
98	MP-13	For relay 13H-PH-6 which switches gyro horizon APN over to inverter HAT-10H	Cockpit
99	MP-3	For filter Q-14A of pump of 1st tank	Fuselage nose section
104	MP-4	For starboard electric board (front)	Cockpit
105	MP-7	For starboard electric board (front)	Cockpit
106	MP-23	For detachment of fin and pressurization of booster section	Fin
107	MP-9	For flap control board	Port console (installed after series C-01)
With- out number Same	Receptable MP20N29T6	For measurement of voltage of NO-750 (2p) Same of NO-750 (17p)	Fuselage nose section
111	MP-23	For passage of conductors through cockpit floor	Cockpit floor at left rear frame 4
112	MP-4	For electrical trigger of port wing cannon	Port wing

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1	2	3	4
113	EP-4	For electrical trigger of fuselage cannon	Between frames 8 and 9, in fuselage nose section, at right, bottom
114	EP-4	For electrical trigger of starboard wing cannon	Starboard wing
115	EP-9	For bunched conductors from buttons of shut-off cocks and ignition switches	Cockpit, port
116	EP-4	For bunched conductors from engine starting buttons	Cockpit, port

10. Delivery List of Equipment

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Nos	Description	Type	Q-ty	Place of installation
1	2	3	4	5
13	Aircraft battery	12CAM28	1	In nose section
23	Contactor to bring airborne battery on mains	KM200M	1	In nose section
33	Receptacle to connect ground supply to airborne mains		1	Port, between frames 18-19
43	Relay box to cut in ground sources, heavy loads and to cut out airborne battery	PMA-200A or PMA-200M	1	Port, between frames Nos 12-13
53	Switch to remove airborne battery and ground power supply from mains	87K	1	Installed on starboard console in cockpit
63	Starter-generator of port engine	ICP-CT-6000A	1	Port engine
73	Starter-generator of starboard engine	ICP-CT-6000A	1	Starboard engine
83	Ballast resistor for port generator	BC-600C	1	Port, between frames 14-15

1	2	3	4	5
99	Ballast resistor for starboard generator	BC-6000	1	Starboard between frames 14-15
109	Differential minimum relay to bring port generator on and remove from mains	DMP-400A	1	Port power supply unit
119	Differential relay to bring starboard generator on and remove from mains	DMP-400A	1	Starboard power supply unit
129	Voltage regulator of port generator	P-27	1	Port power supply unit
139	Voltage regulator of starboard generator	P-27	1	Starboard power supply unit
169	Capacitor of port generator	KBM-31	3	Port power supply unit
179	Capacitor of starboard generator	KBM-31	3	Starboard power supply unit
189	Switch of port generator	2B-45	1	Starboard console in cockpit
199	Switch of starboard generator	2B-45	1	Same
209	Heavy current fuse of port generator	TH-200	1	Port power supply unit
219	Heavy current fuse of starboard generator	TH-200	1	Starboard power supply unit

1	2	3	4	5
229	Ammeter shunt of port generator	A-46	1	Port power supply unit
239	Ammeter shunt of starboard generator	A-46	1	Starboard power supply unit
249	Receptacle to measure current of port generator	48K	1	Port power supply unit
259	Receptacle to measure current of starboard generator	48K	1	Same
269	Receptacle to measure voltage of port generator	48K	1	Same
279	Receptacle to measure voltage	48K	1	Same
289	Relay to cut out generators when ground supply is brought on mains	PH-2	1	Port power supply unit
299	Heavy current fuse in circuit of aircraft battery	TH-400	1	Nose section at the port panel
309	Voltmeter to monitor mains voltage	B-1	1	Instrument panel in cockpit

1	2	3	4	5
319	Circuit breaker of supply circuit to bus No.2	A3C-30	1	Starboard power supply unit
329	Circuit breaker of supply circuit of bus No.4	A3C-25	1	Same
339	Circuit breaker of supply circuit of bus No.3	A3C-40	1	Same
349	Circuit breaker of supply circuit of bus No.1	A3C-30	1	Port power supply unit
359	Circuit breaker in power circuit of pump of 1st tank of unit 495A	A3C-40	1	Port power supply unit
369	Contactor to out in pump of 1st tank	KM-50C	1	Same
379	Fuse in circuit of volt-meter monitoring mains voltage	CH-5	1	Same
403	Stabilizing transformer of port generator	TC-9AM	1	Same
419	Stabilizing transformer of starboard generator	TC-9AM	1	Starboard power supply unit
1E	Circuit breaker in starting circuit of port and starboard engines	A3C-25	1	Port console in cockpit

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1	2	3	4	5
2E	Ignition cut-in pilot lamp of port engine	CMM-51, red	1	Instrument panel, in cockpit
3E	Starting button of starboard engine	204K	1	Same
4E	Starting button of starboard engine	204K	1	Same
5E	Ignition cut-in pilot lamp of starboard engine	CMM-51, red	1	Instrument panel in cockpit
6E	Unit of ignition coils to start port engine	KM-21-E1	1	Port engine
7E	Unit of ignition coils to start starboard engine	KM-21-E1	1	Starboard engine
8E	Main fuel ignition plug of port engine	CD-96	4	Port engine
9E	Main fuel ignition plug of starboard engine	CD-96	4	Starboard engine
10E	Afterburner fuel ignition plug of port engine	CH-02	1	Port engine
11E	Afterburner fuel ignition plug of starboard engine	CH-02	1	Starboard engine
12E	Switch for airborne starting of port engine	88K	1	Port console in cockpit

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1	2	3	4	5
13E	Ratings control panel of starboard engine	EV-3	1	Starboard engine
14E	Ratings control panel of port engine	EV-3	1	Port engine
15E	Switch for airborne starting of starboard engine	23K	1	Port console in cockpit
16E	Ignition coil to start afterburning of port engine	KMM-1A	1	Port engine
17E	Ignition coil to start afterburning of starboard engine	KMM-1A	1	Starboard engine
18E	Starting blocking relay of starboard engine when ICP-CT-6000A operates as generator	PH-2	1	Starboard power supply unit
19E	Starting interlocking relay of port engine when ICP-CT-6000A operates as generator	PH-2	1	Port power supply unit
1M	Panel to start port and starboard engines	HKC-6000E	1	Port between frames 17-18

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1	2	3	4	5
2M	Afterburner cut-in pilot lamp (green) of port engine	Lamp register T-6	1	Instrument panel in cockpit
3M	Afterburner control unit of port and starboard engines	KAQ-2 register	1	Starboard frames 12-13
4M	Afterburner cut-in pilot lamp (green) of starboard engine	Lamp register T-6	1	Instrument panel in cockpit
5M	Electromagnetic valve of starting pump of starboard engine		1	Starboard engine
6M	Same, of port engine		1	Port engine
7M	Contact of hydraulic decelerator in pump HP-10A of starboard engine		1	On pump HP-10A of starboard engine
8M	Contact of hydraulic decelerator in pump HP-10A of port engine		1	On pump HP-10A of port engine

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1	2	3	4	5
9M	Electromagnetic valve of afterburner fuel pump HP-11A of starboard engine		1	On pump HP-11A of starboard engine
10M	Same, of port engine		1	On pump HP-11A of port engine
11M	Circuit breaker of cut-in of 1st tank pump and delivery of constant voltage starting box timer	ASC-5	1	Port console in cockpit
12M	Circuit breaker of 2nd tank pump and pressure warning of 2nd tank pump	ASP-15	1	Same
13M	Filter of 2nd tank pump	Q-14A	1	Port side, frames 13-14, bottom
14M	Pump of 2nd tank	NHB-2	1	Frame 12, bottom
15M	Circuit breaker of pump of 3rd tank	ASP-10	1	Port console in cockpit
16M	Filter of pump of 3rd tank	Q-14A	1	In fuselage tail section between frames 21-22
17M	Pump of 3rd tank	OMP-1	1	In fuselage tail section between frames 21-22, bottom

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1	2	3	4	5
18M	Pump of 4th tank	OMP-1	1	In fuselage tail section between frames 28-29
19M	Circuit breaker of control circuit of shut-off cock of port engine and oil pressure warning circuit of port engine	ASC-5	1	On port console in cockpit
20M	Button to close shut-off cock of port engine	204K	1	On port console in cockpit
21M	Electrically operated pneumatic valve of shut-off cock to close panel pipe line to port engine	3K-48	1	In engine section, near frame 16
22M	Circuit breaker of control circuit of shut-off cock of starboard engine and oil pressure warning circuit of starboard engine	ASC-5	1	On port console in cockpit
23M	Button to close shut-off cock of starboard engine	204K	1	Same

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1	2	3	4	5
24N	Electrically operated pneumatic valve of shut-off cock to close fuel pipe line to starboard engine	3K-13		In engine section, near frame 16
25N	Circuit breaker of wheel brake automatic control unit	A3C-5	1	On port console in cockpit
26N	Pneumatic switch in system of wheel brake automatic control unit	YH-22	1	Behind instrument panel
27N	Pneumatic valve on port wheel	YH-30/1	1	Port wheel
28N	Inertia transmitter of port wheel	YA-23	1	Port wheel
29N	Pneumatic valve on starboard wheel	YH-30/1		Starboard wheel
30N	Inertia transmitter on starboard wheel	YA-23		Same
31N	Circuit breaker of supply circuit of bus No.5	A3C-30		Starboard power supply unit

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1	2	3	4	5
32N	Limit switch to block afterburner cut-in depending on pressure in flap control hydraulic system of port engine	BK-2-14OB-1	1	In fin, starboard
33N	Pressure drop warning lamp of main and booster hydraulic systems	CMI-51, red		Instrument panel
34N	Breaker of control circuit of spring feel mechanism	A3C-5	1	On port console in cockpit
35N	Two-position switch on control stick to control aileron effect mechanism	HK	1	Stick
36N	Electric actuator of aileron	YT-6X	1	In aileron of port wing
37N	Electric actuator of spring feel mechanism of trim	MP-100M	1	In tail section, between frames 26-27, top
38N	Light lamp to indicate position of spring feel mechanism of trim	CMI-51, green		On instrument panel in cockpit

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1	2	3	4	5
39M	Limit switch to signal pressure drop in booster hydraulic system	BK-2-140B-1	1	Frame 15, port
40M	Limit switch of cylinder switch behind cock TA-74M of stabilizer booster	BK-2-140B-1	1	In tail section, port, between frames 26-27
42M	Limit switch to signal pressure drop in main hydraulic system	BK-2-140B-1	1	Frame 15, starboard
43M	Air brakes control switch on engine control lever		1	On engine control lever in cockpit
44M	Button to extend air brakes	204K	1	On control stick in cockpit
46M	Hydroelectric cock to extend air brakes	TA-1B/4	1	In tail section, starboard, frames 24-25
47M	Switch to cut in and out aileron booster	88K	1	On port console, in cockpit
48M	Hydroelectric cock to cut in and out aileron booster	TA-74/3	1	In starboard wing
51M	Switch to cut in and out stabilizer booster	88K	1	On port console in cockpit

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1	2	3	4	5
52M	Hydroelectric cock to cut in and out stabilizer booster	TA-74M/5	1	In tail section, starboard frame 27
53M	Circuit breaker in control circuit of retraction and extension of landing gear, drag chute and flaps	A3C-5	1	On starboard console
54M	Switch to control L.G. extension and retraction	MMH-45	1	On instrument panel in cockpit
55M	Hydroelectric cock to control L.G. extension and retraction	TA-46/3	1	In nose section, port, frame 17
56M	Button to pull out drag chute	204K	1	In cockpit on port console
57M	Electrically operated pneumatic valve to pull out drag chute	9K-48		Tail section, port, between frames 24-25
58M	Button to jettison drag chute	204K	1	On port console
59M	Electrically operated pneumatic valve to jettison drag chute	9K-48		Tail section, port, between frames 24-25

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1	2	3	4	5
60M	Microswitch to retract flaps	KB-6-2	1	Port console flap board
61M	Limit switch of retracted position of port flap	BK-2-140E-1	1	Port wing
62M	Limit switch of retracted position of starboard flap	BK-2-140E-1	1	Starboard wing
63M	Microswitch to extend flaps through 25°	KB-6-2	1	Port console flap board
64M	Microswitch to signal extension of flaps through 25°	KB-6A	1	Port wing
65M	Microswitch to extend flaps through 15°	KB-6-2	1	Port console, flap board
66M	Microswitch to extend flaps through 15°	KB-6A	1	Port wing
67M	Hydroelectric cock to control flaps	TA-46/2	1	In nose section, starboard, frame 19
68M	Relay to release brakes of starboard wheel	PH-2	1	In nose section, frame 8A, bottom

1	2	3	4	5
69M	Electric magnet to control air by-pass band on starboard engine when starting port engine		1	On starboard engine
70M	Electric magnet to control air by-pass band on port engine when starting starboard engine		1	On port engine
71M	Starting fuel electric pump to start engines	HHF-10-9M	1	Over 1st tank between frames 13-14
72M	Contactor to cut in actuator MYC-2 of stabilizer	KM-25M	1	In fuselage tail section between frames 26-27, starboard
74M	Hydroelectric cock to control eyelids of port engine	TA-21	1	Cock No.1 in fin, starboard
75M	Same	TA-21	1	Cock No.2 in fin, starboard
76M	Pneumatic valve to release nose wheel brake	VH-30/1	1	Nose wheel
77M	Inertia transmitter to release nose wheel brake	YA-24	1	Same

1	2	3	4	5
78M	Pilot lamp to indicate landing position of large arm of APY-2	CME-51, green	1	Instrument panel in cockpit
79M	Filter in circuit of pump of 1st tank (unit 495A)	O-37	1	In nose section, between frames 14-15, bottom
80M	Pump of 1st tank	Unit 495A	1	Nose section, frame 12
81M	Contact of afterburning needle of pump HP-11A of starboard engine		1	On starboard engine
82M	Contact of afterburning needle of pump HP-11A of port engine		1	On port engine
83M	Limit switch to block afterburner circuit out-in depending on pressure of hydraulic fluid in system of jet nozzle eyelids	BK-2-140B-1	1	In fin, starboard
84M	Hydroelectric cock to control eyelids of starboard engine	TA-21	1	Cock No.1 in fin, starboard
85M	Same	TA-21	1	Cock No.2 in fin, starboard

1	2	3	4	5
86M	Breaker of afterburner out-in circuit of port engine	A3C-5	1	On port console
87M	Breaker of afterburner out-in circuit of starboard engine	A3C-5	1	Same
88M	Breaker of eyelid control circuit of port and starboard engines	A3C-10	1	In port power supply unit
91M	Mismatch transmitter to control stabilizer from control stick through actuator MVC-2	AP-5	1	Fuselage tail section, between frames 26-27, top
92M	Relay to block out-in of afterburning and maximum rating on air by-pass band for port engine	PH-2	1	In starboard power supply unit
94M	Relay to block out-in of afterburning and maximum rating on air by-pass band for starboard engine	PH-2	1	Same

1	2	3	4	5
97M	Filter in circuit of 4th tank pump	Q-14A	1	In tail section between frames 28-29, bottom
98M	Circuit breaker of 4th tank	A3P-10	1	On port console in cockpit
100M	Switch to control aileron trim tab	HH-45	1	Same
101M	Circuit breaker of circuit actuator NYC-2	A3C-30	1	In starboard power supply unit
102M	Circuit breaker of APY-2	A3C-15	1	Same
103M	Relay to block extension of air brakes	TKE-58ND	1	In fuselage tail section, between frames 26-27
104M	Mechanism to alter arm in stabilizer control system	Mechanism APY-2A	1	In fuselage tail section between frames 25-26, top
105M	Automatic control unit of mechanism APY-2A	Control unit of APY-2A	1	At back of instrument panel in cockpit
106M	AUTOMATIC - MANUAL switch of APY-2A	88K	1	On port console in cockpit
107M	Manual control switch of mechanism APY-2A	HH-45	1	Same

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1	2	3	4	5
108M	Position indicator of APY-2A	Specially adjusted voltmeter B-1	1	On instrument panel in cockpit
109M	Breaker of control circuit of system APY-2A	A3C-5	1	On starboard console in cockpit
113M	Actuator of stabilizer	NYC-2	1	In tail section, between frames 29-30, top
116M	Breaker of contactor (72M) circuit of NYC-2	A3C-5	1	On starboard console in cockpit
117M	Button to check lamp of arm APY	5K	1	Instrument panel
118M	Limit switch of cylinder switch behind cock PA-74M/5	BK-2-140B-1		In fuselage tail section, port between frames 26-27
162M	Time-lag fuse in circuit of contactor (72M)	WH-10		Starboard power supply unit
174M	Time-lag fuse in supply circuit of transmitter DP-5	WH-5		In fuselage tail section, starboard, between frames 26-27
1K	Pressure indicator of 2nd tank pump	CD-3	1	In nose section, between frames 13-14, bottom

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1	2	3	4	5
2K	Pressure pilot lamp of 2nd tank pump	СМН-51, green	1	On port console, in cockpit
3K	Pressure indicator of 3rd - 4th tank pump	СД-3	1	In tail section, frame 22, bottom
4K	Pressure pilot lamp of 3rd and 4th tanks pump	СМН-51, green	1	On port console, in cockpit
5K	Circuit breaker of engine control instruments	АЗС-5	1	Same
6K	Pressure indicator of 1st tank pump	СД-3	1	Engine section, on frame 15
7K	Fuel level indicator of drop tanks	СД-3	1	In nose section, port frame 15
8K	Fuel level pilot lamp of drop tanks	СМН-51, green	1	On instrument panel, bottom
9K	Fuse in circuit of fuel quantity gauge and flow-meter	СН-10	1	In fuse box, in nose section between frames 5-6A
10K	Fire warning lamp	СМН-51, red	1	On port console, in cockpit
11K	Afterburner fuel minimum pressure warning mechanism of port engine	АСД-2	1	On port engine

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1	2	3	4	5
12K	Pressure pilot lamp of pump of 1st tank	Lamp register T-6	1	On instrument panel in cockpit
13K	Transmitter of flow-meter	ТЭС-1417	1	In nose section, top
14K	Flowmeter indicator	ТПЗ-52	1	On instrument panel in cockpit
15K	Fuel level pilot lamp	Lamp register T-6	1	Same
16K	Flowmeter transmitter	PTC-16	1	In nose section, port, between frames 15-16
17K	Thyratron interrupter	НТ-51А НТ-51М is installed series 8-51 in door between frames 14 and 15, port side	1	Port side, frame 12 in region of power supply unit
18K	Limit oil pressure warning mechanism of port engine	2СДУ-5	1	On port engine
19K	Limit oil pressure warning lamp of port engine	Lamp register T-6	1	On instrument panel in cockpit

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1	2	3	4	5
20K	Limit oil pressure warning mechanism of starboard engine	20TV-5	1	Starboard engine
21K	Limit of pressure warning lamp of starboard engine	Lamp register T-6	1	On instrument panel in cockpit
22K	Tachometer indicator	2TB-15-1	1	On instrument panel in cockpit
23K	Tachometer transmitter of port engine	AT-3	1	On port engine
24K	Tachometer transmitter of starboard engine	AT-3	1	On starboard engine
25K	Exhaust gas temperature indicator	2TBT-411	1	On instrument panel in cockpit
26K	Adapter of thermocouples for port engine		1	In fuselage tail section
27K	Thermocouples of port engine	T-1	4	On port engine
28K	Adapter of thermocouples for starboard engine		1	In fuselage tail section
29K	Thermocouples of starboard engine	T-1	4	On starboard engine
30K	Thermosensitive units	AQ-155A-3K	3	In fuselage, tail section frame 22

1	2	3	4	5
31K	Fire-extinguishing button	205K	1	On port console in cockpit
32K	Fire-extinguishing bottle		1	In nose section, port, between frames 13-14, bottom
33K	Afterburner fuel minimum pressure warning mechanism of starboard engine	ACD-2	1	On starboard engine
35K	Cut-in relay of fire alarm circuit	PN-3	1	At back of instrument panel
36K	Relay to control lamps of lamp register T-6	PN-6	1	Same
37K	Button to control lamps of lamp register T-6	Lamp register T-6	1	In instrument panel
1C	Lamp to indicate disconnection of port generator	CJH-51, red	1	Same
2C	Lamp to indicate disconnection of starboard generator from mains	CJH-51, red	1	On instrument panel

1	2	3	4	5
3C	Resistor to change luminous intensity of position lights	HO-10-5 ohms	1	At back of instrument panel
4C	Same	Same	1	Same
5C	Breaker in circuit of cockpit heating, SVI-53, de-icer, cockpit lamp	ASC-5	1	On port console in cockpit
6C	Relay to indicate operation of port generator	PH-2	1	On port power supply unit
7C	Relay to indicate operation of starboard generator	PH-2	1	In starboard power supply unit
8C	Relay to change over lights	PH-2	1	Under pilot's floor between frames 8-7A
9C	Circuit breaker of lights	ASC-25	1	On starboard console in cockpit
10C	Switch to change over control of lights	PH-45	1	On instrument panel in cockpit
11C	Landing light	MCB-45, left	1	In nose section, port

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1	2	3	4	5
12C	Breaker in circuit used to signal position of landing gear, to control air brakes, to signal pressure drop in hydraulic system, to supply power to position lights	ASC-5	1	On starboard console in cockpit
13C	Limit switch to signal extended position of left strut	BK-44	1	At port strut
14C	Same, to signal retracted position	BK-44	1	Same
15C	Limit switch to signal extended position of nose strut	BK-44	1	At nose strut
16C	Same, to signal retracted position	BK-44	1	Same
17C	Limit switch to signal extended position of starboard strut	BK-44	1	At starboard strut
18C	Same, to signal retracted position	BK-44	1	Same

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1	2	3	4	5
19C	Limit switch to signal extension of air brakes	BK2-140B-1	1	In fuselage tail, section port, between frames 22A-23
20C	Flight and landing control board	ППГ-2	1	On instrument panel
21C	Lamp of extension external signalling of port strut	XC-39	1	On port strut
22C	Same of nose strut	Same	1	On nose strut
23C	Same of starboard strut	Same	1	On starboard strut
24C	Relay to cut in external indicator of landing gear position	ПП-3	1	Under the pilot's floor between frames 7A-8
25C	Switch of position lights	ПЗПН-20	1	On port console
26C	Position light on port wing	БАНО-45, red	1	On port wing
27C	Position light on starboard wing	БАНО-45, green	1	On starboard wing
28C	Tail light	XC-39	1	In fin
29C	Circuit breaker of hydraulic boosters of stabilizer and ailerons	A3C-5	1	On starboard console
30C	Switch of signal flares	87K	1	On port console

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1	2	3	4	5
31C	Button to fire yellow flares		1	On port console
32C	Same, to fire green flares		1	Same
33C	Same, to fire red flares		1	Same
34C	Same, to fire white flares		1	Same
35C	Electric mechanism to fire yellow flares	ЭКР-46	1	In fin, port
36C	Electric mechanism to fire green flares	Same		Same
37C	Same, to fire red flares	Same	1	Same
38C	Same, to fire white flares	Same	1	Same
39C	Taxiing light	ФР-100	1	L.G. nose strut
40C	Rheostat of port rear lamp of АРВФФМ	РВФФ-45	1	Starboard, in cockpit
41C	Port rear lamp	АРВФФМ-45	1	On port panel, in cockpit
42C	Circuit breaker of receptacle of portable lamp, of port front and starboard lamps of АРВФФМ-45 and signal flares	A3C-5	1	Starboard console
43C	Receptacle for portable lamp	47K	1	In port wing

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1	2	3	4	5
44C	Rheostat of starboard lamp of APYQOM	PYQO-45	1	Starboard, in cockpit
45C	Starboard lamp	APYQOM-45	1	Same
46C	Rheostat of port front lamp of APYQOM-45	PYQO-45	1	Same
47C	Port front lamp	APYQOM-45	1	Port, in cockpit
48C	Pilot lamp of flaps retracted position	CM-30	1	On flaps board, port console in cockpit
49C	Pilot lamp of flaps landing position	CM-30	1	Same
50C	Pilot lamp of take-off position of flaps	CM-30	1	Same
51C	Cockpit lamp	KMCPK-45	1	Starboard, cockpit
53C	Fuse in control circuit of landing light	CM-5	1	On instrument panel
1H	Circuit breaker of emergency supply of APM-1	A3C-5	1	On starboard console in cockpit
2H	Inverter for emergency supply of APM-1	HAT-10H	1	Under the pilot's floor, port, between frames 6-7
3H	Gyro horizon	ATM-1	1	On instrument panel, in cockpit

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1	2	3	4	5
4H	Circuit breaker of FMK-1 and inverter NT-125	A3C-10	1	On starboard console, in cockpit
5H	Inverter for FMK-1 and APM-1	NT-125	1	Starboard, frame 9
6H	Connection box of FMK-1	CK-11	1	Under cockpit floor
7H	Correction mechanism of FMK-1	KM	1	Behind instrument panel, port
8H	Induction transmitter FMK-1	WD	1	In fin
9H	Gyro induction compass FMK-1	F-3	1	Under cockpit floor
10H	Amplifier of FMK-1	Y-6M	1	Same
11H	Match button of FMK-1	5K	1	Instrument panel in cockpit
13H	Relay to change APM-1 over to emergency converter	PH-3	1	At back of instrument panel in cockpit
16H	Turn indicator	BYM-53	1	Instrument panel in cockpit
17H	Compass indicator	YTP-3	1	Same
21H	Switch of correction	BK-53P	1	Port, frame 9
1P	Switch of station PCMY-4	87K	1	Starboard console in cockpit, rear board

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1	2	3	4	5
2P	Inverter for A.C. power supply of PCNV-4, APK-5, MPH, CPO, fuel quantity gauge and flowmeter	HO-750	1	Under pilot's floor, starboard, frames 4 and 5A
3P	Circuit breaker of radio station, APK-5, MPH, CPO, fuel quantity gauge and flowmeter	ASC-10		Starboard console in cockpit
4P	Relay of radio station	PH-2	1	Starboard, under pilot's floor, in inverter box, between frames 5A and 6
5P	Relay to cut in D.C. and A.C. emergency supply to PCNV-4, APK-5, MPH, CPO, fuel quantity gauge and flowmeter	PH-6	1	Starboard, under pilot's floor, in inverter box, between frames 5A and 6
6P	Fuse in A.C. circuit of CPO	CH-10		Same
7P	Fuse in A.C. circuit of radio station	CH-10	1	Starboard, under pilot's floor, in inverter box, between frames 5 and 6A
8P	Fuse in A.C. circuit of APK-5	CH-10	1	Same
9P	Control desk of station	CPO	1	Starboard, cockpit

1	2	3	4	5
12P	Rectifier unit	PCNV-4	1	Fuselage, nose section, bottom, frames 5 and 6
13P	Control board of APK-5	APK-5	1	In cockpit, starboard console
14P	Receiver of APK-5	APK-5	1	Under pilot's floor starboard
15P	Circuit breaker of station CPD-1M	ASC-10	1	Starboard console
16P	Switch to cut in emergency supply for PCNV-4, APK, MPH, CPO, fuel quantity gauge and flowmeter	87K	1	Starboard console in cockpit
17P	Inverter for A.C. power supply of radar ranging unit and sight ACH-5H	HO-750	1	Under pilot's floor, port, frames 4 and 5A
20P	Fuse in A.C. circuit of station	CH-10	1	Starboard, under pilot's floor, in inverter box, frames 5 and 6A
21P	Relay of radar ranging unit	PH-2	1	Same
22P	Assembly No.6 of radar ranging unit	CPD-1M		Port, in cockpit

1	2	3	4	5
23P	Circuit breaker of SIRENA	A3C-5	1	Starboard console in cockpit
24P	Unit No.3 of SIRENA station	Unit No.3 SIRENA	1	Port, in cockpit, at frame 5
27P	Receptacle to connect PY-11A of unit PB-2	48K	1	Nose section, port
28P	Bell of marker receiver	MPH-48H		Starboard, cockpit
29P	Filter for PB-2	Q34-15	1	Nose section, port
30P	Time-lag fuse in power circuit of inverter HO-750 (2p)	WH-75	1	Supply unit, frames 13 and 14
31P	Circuit breaker of emergency supply for PCMV-4, APK, MPH, CPO, fuel quantity gauge and flowmeter	A3C-10	1	Port power supply unit
32P	Time-lag fuse in power circuit of inverter HO-750	WH-75	1	Same
33P	Circuit breaker of PB-2, MPH	A3C-5	1	Starboard console
35P	Fuse in D.C. circuit of station APK-5	CH-10	1	Starboard, under pilot's floor, in inverter box, between frames 5 and 6A

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1	2	3	4	5
36P	Fuse in D.C. circuit of PCMV-4	CH-10	1	Starboard, under pilot's floor, in inverter box, frames 5 and 6A
37P	Fuse in D.C. circuit of station CPO	CH-10	1	Same
40P	Receptacle to check voltage of inverter HO-750 (2p)	Receptacle MP20M29T6	1	Starboard, frames 5A and 6, bottom
41P	Receptacle to check voltage of inverter HO-750 (17p)	Receptacle MP20M29T6	1	Same
43P	Destruction button of station CPO	CPO	1	Starboard, cockpit, under windshield
44P	Inverter box		1	Fuselage nose section, starboard, bottom of frames 5A and 6
1E	Suspension lock of port bomb or tank	ED3-56	1	Port wing
2E	Suspension lock of starboard bomb or tank	ED3-56	1	Starboard wing
3E	Pilot lamp of suspension of port bomb	CMH-51, green	1	Bomb release control board on instrument panel

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1	2	3	4	5
4B	Pilot lamp of suspension of starboard bomb	CNH-51, green	1	Bomb release control board on instrument panel
5B	Pilot lamp of ARMED bomb release	CNH-51, red	1	Same
6B	Circuit breaker of bomb release	A3C-10	1	Starboard console
7B	release ARMED - SAFE (B3PMB-HEB3PMB) switch of tactical bomb release	2B-45	1	Bomb board on instrument panel
8B	Relay for tactical bomb release	PH-2	1	At back of instrument panel
9B	Circuit breaker of armed bomb release	A3C-10	1	Starboard console in cockpit
10B	Circuit breaker of emergency bomb release	A3C-10	1	Same
11B	Button to jettison bombs or tanks	205K	1	Board on port side in cockpit
12B	Microswitch to jettison tanks simultaneously	KB-6A	1	Port wing
13B	Same	KB-6A	1	Starboard wing

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1	2	3	4	5
1T	Clock heater	A4X0	1	Instrument panel
2T	Cockpit air heating switch	ПЗПН-20	1	Starboard console
3T	Thermoregulator of cockpit air	TPTBK-45M	1	Port, cockpit, frame 8A
4T	Air electrical distributor	Unit 525	1	Nose section, starboard, between frames 17-18, top
5T	Circuit breaker of heating for air speed tube ПВД-4, clock	A3C-10	1	Starboard console
6T	Heating of nose-mounted air speed tube ПВД-4	ПВД-4	1	Fuselage nose section
7T	Heater of emergency air speed tube	TH-156	1	Starboard, between frames 3-4
8T	Button to operate de-icer	5K	1	Port, cockpit
9T	Electrically operated pneumatic cock of de-icer	ЭК-48	1	Port, between frames 4-5A, bottom
10T	Circuit breaker of TH-156 heater	A3C-10	1	Starboard console in cockpit
11T	Circuit breaker of sight АСН-5H	A3C-10	1	Same

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1	2	3	4	5
2N	Filter in supply circuit of sight ACH-5H	Q-14A	1	Cockpit, at frame 9
3N	Voltage stabilizer, unit No.9	ACH-5H	1	Cockpit, starboard, between frames 8-9
4N	Sight head, unit No.1	ACH-5H	1	Over instrument panel
5N	Altitude unit, unit No.6	ACH-5H	1	Nose section
6N	Distribution box, unit No.5	ACH-5H	1	Starboard, between frames 8-9 in cockpit
8N	Computer, unit No.2	ACH-5H	1	Port, between frames 8-9, cockpit
9N	Circuit breaker of weapons and camera mount controllers	A3C-5	1	Starboard console, cockpit
10N	Weapons firing button	204K	1	Control stick
11N	Relay to cut in cannons and camera mount controllers	MP-1	1	At back of instrument panel
12N	Circuit breaker of camera mount controllers	A3C-10	1	Starboard console in cockpit
13N	Timer of camera gun AKC-3M	BM-2	1	Nose section, frame 1
14N	Camera gun	AKC-3M	1	Front cone
15N	Camera mount controller	CT-45	1	
16N	Circuit breaker of port cannon	A3C-10	1	Starboard console

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1	2	3	4	5
17N	Circuit breaker of nose cannon	A3C-10	1	Starboard console
18N	Same, of starboard cannon	A3C-10	1	Same
19N	Rounds counter of port cannon	3-M-005	1	Bomb board on instrument panel
20N	Same, of nose cannon	3-M-005	1	Same
21N	Same, of starboard cannon	3-M-005	1	Same
22N	READY-TO-FIRE signal relay of port cannon	PH-2	1	At back of instrument panel
23N	Same, of nose cannon	PH-2	1	Same
24N	Same, of starboard cannon	PH-2	1	Same
25N	Electric trigger of port cannon	HP-30	1	Port wing
26N	Same, of nose cannon	HP-30	1	Starboard
27N	Same, of starboard cannon	HP-30	1	Starboard wing
28N	Button to reload port cannon	5K	1	Reloading board, port console, cockpit
29N	Same, to reload nose cannon	5K	1	Same
30N	Same, to reload starboard cannon	5K	1	Same
31N	Electrically operated pneumatic valve to reload port cannon	3K-48	1	Port wing

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1	2	3	4	5
32П	Electrically operated pneumatic valve to reload nose cannon	ЭК-48	1	Starboard
33П	Same, to reload right cannon	ЭК-48	1	Starboard wing
35П	Relay box, unit No.8	АСП-5Н	1	In cockpit, between frames 8-9, port
36П	Zero gyroscope, unit No.3	АСП-5Н	1	In cockpit, frame 9
37П	Amplification, unit No.4	АСП-5Н	1	In cockpit, port, between frames 8-9
38П	Sight control desk, unit No.7	АСП-5Н	1	Port desk
39П	Damping button	204K	1	Control stick
40П	Target discharge button of station СРД-1Н	204K	1	Same
41П	Potentiometer of manual range input	АСП-5Н	1	Engine control lever
42П	Circuit breaker of supply for sight and sight heater	А3С-20	1	Starboard console
43П	Fuse in A.C. circuit of sight	СП-10	1	Starboard, under pilot's floor

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1	2	3	4	5
44П	Sight cut-in relay	ПН-2	1	Inverter box, under pilot's floor, star- board, between frames 5A and 6
45П	Relay to cut in radar ranging unit and sight АСП-5Н when powerful source is brought on line	МР-1	1	At back of instrument panel
47П	Unit C-5. Starboard wing - unit in place of bombs	Unit C-5	1	Starboard wing
48П	Unit C-5. Starboard wing - main rack	C-5	1	Same
49П	Rocket suspension lock, port wing	БДЗ-56	1	Port wing
50П	Rocket suspension lock, starboard wing	БДЗ-56	1	Starboard wing
51П	Rocket emergency jettison- ing button	204K	1	Port console
52П	Circuit breaker of C-5	А3С-10	1	Starboard console
53П	Salvo switch	ППН-45	1	Port console

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1	2	3	4	5
54H	Relay to cut in firing circuit of C-5	PH-3	1	At back of instrument panel
55H	Relay to block firing of C-5 according to L.G. position	PH-2	1	Under pilot's floor, between frames 8-7A
56H	Signal unit of C-5	C-5	1	Starboard, cockpit
57H	Control unit of C-5	HY-2	1	On port console
58H	Unit C-5. Port wing, main rack	C-5	1	Port wing
59H	Unit C-5. Port wing, unit in place of bombs	C-5	1	Same

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Chapter II

RADIO EQUIPMENT

General

The purpose of the radio equipment is as follows:

1. U.S.W. radio station PCW-4 maintains tactical and operational communication with other aircraft and ground stations.

2. Automatic radio compass APK-5 provides aircraft flight control and is used as an aid to navigation.

3. Radio altimeter PB-2 determines true altitude of the aircraft above the ground.

4. Marker receiver MPH-48H determines the moment the aircraft flies over the radio marker beacon.

Radio equipment of APK-5, PB-2 and MPH-48H is used for flight control and radio navigation and provides means for instrument landing by instrument landing system OCH-48.

5. Aircraft transponder CPO and radar station SIRENA-2 used for rear hemisphere sweep serve the purpose of radar identification and warning.

6. Radio range finder CPM-1M is a radar station which serves for measuring the distance to the target and for automatic inserting the range correction into sight AGH-5H.

7. Static dischargers on the wing tips and bonding system of all major units and components of the aircraft are intended for noise suppression and reduction of fire hazard.

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I. Radio Communication Station PCW-4Purpose

Radio station PCW-4 is an U.S.W. transmitter receiver radio set designed for telephony. It is used for communication with ground radio stations and other aircraft during flight.

Radio station PCW-4 may be pretuned to six waves on ground so as to make possible to use any of them in flight without fine tuning.

Complement

Radio station PCW-4 includes;

1. Transceiver - units A and B mounted on a common bracket.
2. Rectifying unit B-1.
3. Control desk unit H-1.
4. Function cables.
5. Rod antenna.

Arrangement of Radio Station Units

The PCW-4 transceiver is located in the upper accessories compartment between frames 1 and 3.

The transceiver is composed of units: transmitter (unit A) and receiver (unit B) shock-mounted on a common bracket.

Units A and B are installed with their front panels up (in the horizontal plane).

The bracket with the units is secured through type 271C shock absorbers to a stamped dural frame the front part of which is bolted to the stringer flanges along air-intake duct sides, while its rear part is fastened to the cross-bar.

The bracket is turned relative to the aircraft fore-and-aft axis and is shifted to the starboard side.

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Access to the transceiver is provided by the upper hatch in accessories compartment. To remove units A and B, open the upper hatch cover, disconnect the cables and R.F. feeder, back out two bolts securing the panel to the cross-bar with wrench No.14, unscrew the screws fastening the shock-mounted panel to the stringer and take out the units together with the bracket and panel.

The design of the bracket provides for separate removal of unit A or B, without removing the bracket itself.

Unit B-1 is installed between starboard frames 5 and 6 under cockpit floor, on rubber shock absorbers. The shock-absorbing frame is welded of steel tubes and mounts four absorbers of unit B-1.

The shock-absorbing frame is easily removable, being secured to the aircraft structure through welded brackets with spring bolts. The left side of the frame is fastened on the brackets riveted to the support profile, while its right side on the welded control rod is secured to the fuselage longitudinal beam.

For access to unit B-1, remove the starboard cannon fairing, the cover of the starboard lower hole and the starboard cannon. To remove unit B-1, disconnect the three cables, take out three studs (with springs) fastening the frame to the profile and a stud securing the control rod lower end to the longitudinal beam.

Access to and removal of unit B-1 is possible, but with the starboard fuselage cannon removed.

Unit H-1, the PCW-4 station control desk, is installed in the cockpit, on the port console frame in front of the throttle control lever. The front panel with control buttons is in the horizontal plane.

Unit H-1 is fastened by a shaped bolt inserted into the frame clamps. On the throttle control lever side the unit is secured to the port console frame with two screws.

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Control buttons and switches are free for access.

For unit П-1 removal, take off the port console cover, cut off four connectors, back out two screws fastening unit П-1 and, moving the unit back and down, take it out.

On the port console, between frames 7 and 8 and behind the throttle control lever is installed a button marked ALARM (ТРЕВОГА) used for sending an alarm signal. The button is placed in the centre of the red-enamelled ring, 100mm wide.

To trigger the transmitter when the radio station is operating the throttle control lever has a triggering button.

When depressing the button with the left-hand thumb, the operator may keep his left hand on the throttle control lever.

All units of radio station PCNV-4 are connected by means of cables and R.F. feeders.

2. Radio Compass APK-5

Purpose

Automatic radio compass APK-5 is designed for navigating the aircraft with the aid of homing and broadcasting stations and radio beacons at a distance of 180 to 200 km., for estimation of aircraft position in space and instrument landing judgement.

Radio compass APK-5 complies with the following navigational tasks.

1. Flying towards the radio station with visual course indication.
2. Flying towards the radio station with aural course indication.
3. Flying from the radio station (the compass is used as an auxiliary means).
4. Determination of drift angles and wind vectors.

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5. Finding the radio station bearings by radio compass indicator and aurally.

6. To give zone or azimuth by the radio compass operating on modulated oscillations.

Radio compass APK-5 comes completed as follows: receiver, control board, inboard loop antenna with dehydrator, canopy antenna, three-position switch, switch INNER - OUTER (БЛИЖНЯЯ, ДАЛЬНЯЯ) and course indicator (included in gyro compass ГНК-1 set).

Arrangement of radio compass units:

APK-5 receiver is installed in the lower accessories compartment between frames 6 and 7A (under the cockpit floor) on riveted duralumin bracket fastening the receiver shock-mount.

The bracket, which is actually two diaphragms linked together by straps is rigidly connected with the fuselage structure.

Both the diaphragms are riveted to the fuselage lower beam.

The receiver is located on the aircraft with the front panel toward starboard.

For access to the receiver front panel, take off the starboard lower hole cover, fuselage cannon and housings.

To remove the receiver from the aircraft, proceed as instructed above; besides, take off the cover of the lower port hole (light access hole), disconnect the connectors, flexible shaft, bonding jumper, free the antenna lead-in from the clip and back out three screws fastening the receiver to the bracket.

Take out two spring studs on the port side and remove the receiver through the port access hole.

Inboard loop antenna (radio compass loop) is installed in a specially stamped-out hole of the lower beam, between frames 5A and 6, strictly along the aircraft fore-and-aft axis.

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To facilitate the installation of the loop in the indicated direction the radio compass loop and the access hole bear red enamel marks.

The radio compass loop is bolted to the base carrying eight shock absorbers. The latter are fastened to the stamped duralumin cup riveted of two parts. The cup is secured on the access hole edging together with protection glass which protects the fuselage contour and keeps the radio compass and marker receiver loops away from dust and moisture.

There is a screen grid on the loop to suppress noise caused during the aircraft equipment operation.

The radio compass loop is installed with the connectors toward port side.

To remove the loop, unscrew two connectors on the loop body, back out the bolts fastening the protection glass and loop, take away the glass and then remove radio compass loop through the lower access hole.

The open non-directional antenna is on the inner surface of the canopy sliding section glass.

This antenna consists of five elements cemented to the canopy. The elements terminate in a common lead linked to the antenna downlead detachable connector placed at the canopy lower base at the right side.

The respective part of the connector is on the armoured back plate of the pilot's seat.

The antenna is coupled to the receiver through the antenna downlead stretching from the antenna via split connector, via sealed adapter in the cockpit floor, to the front panel of the radio compass receiver.

With the canopy open, the antenna connector is open and the canopy antenna disconnected with the receiver.

The coupling between the receiver and loop is maintained via two cables: R.F. cable A2-A3 and supply cable A4. Receiver plug A1 is cabled to the control board through a 26-terminal block in the cockpit floor.

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The receiver is tuned from the cockpit by means of a flexible shaft.

The tuning knob, which is on the control board, is coupled with the flexible shaft end, the other end of the shaft being connected to the receiver.

The wiring to the course indicator, three-position switch and switch INNER-OUTER is laid together with power wiring.

The plotting board for plotting radio data is secured on the box of switch INNER-OUTER.

3. Radio Altimeter PB-2

Purpose

Low-altitude radio altimeter PB-2 is designated for determining the absolute altitude of flight over earth in the range of 0 to 1200 m.

The radio altimeter is used in adverse weather conditions, during cloud breaking, or when landing in poor visibility. Used in conjunction with other navigational means the radio altimeter gives instrument landing judgement, offering a reliable control over aircraft descent from an altitude of 20 to 30 m.

With considerable pitching and rolling (more than 45°) the radio altimeter readings are erroneous and, therefore, should not be used.

Radio altimeter PB-2 comes complete as follows:

1. Transceiver.
2. Altitude indicator HFB-46.
3. Converter PY-11AM.
4. Antennas - receiving and transmitting.
5. Junction cables and R.F. feeders.

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Arrangement of PB-2 Units

PB-2 transceiver is located in the upper (front) accessories compartment between frames Nos 3 and 4 at port side.

The transceiver is installed on four rubber shock absorbers with connectors toward port side. The transceiver is easily removable. The upper hole gives free access to the transceiver unit.

To remove the unit from the shock-mount, unfasten two catch-clips and disconnect the connectors found on the unit front panel.

To remove the unit from the aircraft, disconnect two power cable connectors and two R.F. feeders, take off the bonding strip, pull out two spring studs and remove the unit together with the shock-mount.

Altitude indicator HPB-46 is placed to the left of the instrument panel retractable part. The indicator is screwed to the instrument panel with two screws and is coupled to the transceiver with a shielded cable which runs at port side through a hermetically sealed connector on frame 4.

Converter PY-11AM is mounted in the front accessories compartment between frames 3 and 4 at the left side.

The converter is fastened with two clamps made of sheet steel.

A bonding strip is run from the converter to the horizontal stiffener.

The converter is coupled to the PB-2 transceiver with shielded cable.

To dismantle the converter, open the access hole cover, take off transceiver PB-2 and its mount and remove the converter.

Radio altimeter antennas - both receiving and transmitting are installed on the inner wing surface.

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The receiving antenna is placed on the starboard outer wing panel between ribs 26 and 27.

The transmitting antenna is located on the port outer wing panel, between nose sections of ribs 3 and 4.

Each antenna is secured by four screws with anchor nuts riveted to the wing skin on the inner side.

The antenna bonding is accomplished by stripping the wing surface under the antenna base.

The antennas are coupled to the transceiver by R.F. feeders.

Stretching from the receiving antenna, the R.F. feeder comes out of the wing and into the fuselage near frame 15, being further laid along starboard side up to frame No.9 where it is passed to the port side.

Then, together with the R.F. feeder coming out of the wing into the fuselage near frame 9, it is laid along fuselage port side and in the L.G. nose leg well.

Out of the well both the feeders are led through the hole in the horizontal stiffener into the front accessories compartment to transceiver PB-2.

The R.F. feeder coming from the receiving antenna has a technological joint at its wing outlet.

4. Marker Receiver MPN-48HPurpose

The marker receiver is used for determining the moment of aircraft flying over the radio marker beacon antenna. This moment is indicated by the ringing bell and pilot lamp on the instrument board lighting.

The marker receiver comes complete as follows:

1. Receiver MPN-48H.
2. Inboard loop antenna.
3. Bell.
4. Pilot lamp.

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Arrangement of MPN-48N Units

The marker receiver is placed in the lower accessories compartment at port side in front of frame 9 (with the front panel toward port side) on a bracket stamped out of sheet duralumin.

Through its shock-mount the receiver is secured to the bracket by means of a spring-loaded clamp, from frame 9 side, and with the help of two loops with a spring pin - from the side of the ammunition container access hole.

The receiver is mounted and dismounted through the ammunition container access hole. For access to the receiver front panel there is a small hole in the fuselage skin.

Between the receiver panel and the aircraft structure a bonding strip is installed.

The inboard loop antenna is located below between frames 6 and 7A on a specially made place found on the longitudinal beam. The antenna is installed through the side access hole and is fastened to the access hole flanging with twenty four bolts.

Bonding is accomplished by filing the contacting surfaces of the fuselage and antenna.

From the outside the loop is covered by a plexiglass protecting the loop from dust and moisture.

The loop is coupled to the receiver via a R.F. feeder.

The MPN-48N marker receiver bell is mounted in the cockpit at starboard, near frame 8 (starboard console). The bell is secured to the panel with four screws with anchor nuts riveted to the panel, which in its turn is riveted to the fuselage structure.

To mount and dismount the bell, take off the rear panel of the starboard console.

The wire running from the bell to the receiver is led together with the bunched conductors of the APK-5 radio

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compass through a hermetically sealed 26-terminal connector in the cockpit floor.

Pilot lamp CMU-K is installed on the retractable part of the instrument panel under the red light filter bearing the inscription MARKER (МАРКЕР).

5. Tail Warning Radar SIRENA-2Purpose

Tail warning radar SIRENA-2 is used for warning the pilot of the aircraft tail irradiation given by the radio range finder or radar sight.

Radar SIRENA-2 is equipped with a sound indicator. The audio-frequency at the receiver output varying, it is possible to know whether the aircraft with the irradiating antenna is approaching or lagging behind.

Radar SIRENA-2 comes complete as follows:

1. Receiving antenna and detector head (unit No.1).
2. Amplifier-and-indicator unit (unit No.2).
3. Control board (unit No.3).
4. R.F. feeder.

Arrangement of Units

Unit No.1 is installed in the upper fin cowl along the aircraft fore-and-aft axis.

With respect to the aircraft axes unit No.1 should be installed to an accuracy of $\pm 1.5^\circ$.

Unit No.1 is fastened to the cowl skin by means of two clamps and a bracket.

The clamps are rigidly connected with the cowl skin. The shock-mounted bracket with the unit fastened to it is secured on the clamps.

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On mounting unit No.1, the access hole in the fin cowl is closed by a cover fastened by screws. The cover is actually a casing with a foam plastic disc beaded into it.

Unit No.2 is mounted in the fin port hole and is fastened there to a base rigidly secured to the fin diaphragm by four bolts.

The unit is so fastened as to make it possible to remove it from the base without unscrewing the bolts fastening the base to the diaphragm. To dismantle the unit, it is enough to unscrew the box nut fixing the unit to the base.

The fact that the unit and its base are insulated from the fin diaphragm allowed the use of bifilar wiring to feed the unit.

Bifilar wiring makes it possible to remove the influence of the magnetic field caused by one-wire system over gyro compass PWC-1 operation (in two-wire systems unlike magnetic fields are cancelled).

Besides, the minus wire of the bifilar wiring is also used as a bonding jumper for the unit body.

The unit installed on insulators (washer and sleeve), the current flows through the minus wire.

Should the unit be installed without the insulators, the current would pass from the unit body to the aircraft structure by-passing the wire. This would create a like field around the plus wire, adversely affecting the compass operation.

R.P. feeder, 1.8 m. long, is laid between units Nos 1 and 2.

The feeder length is strictly adjusted with respect to the units and therefore should not be changed. The feeder is laid through the holes in ribs 17 and 20 from unit No.2 and is further stretched to unit No.1 through locks at rib 20.

Unit No.3, the tail warning radar control board, is installed at the cockpit port side, on under-canopy stiffener,

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between frames 5 and 6. The unit is secured with two screws to the panel fastened to the under-canopy stiffener with a lock and two bolts. The technological joint of unit No.3 is clamped to the under-canopy stiffener above the unit.

The wiring in the front part of the fuselage is made of ENBMS-0.75⁰ wire and is run as follows:

From the technological joint of unit No.3 behind the instrument panel toward starboard;

From the instrument panel under starboard console together with power wire to connector WP-23 on frame 9 starboard.

From frame 9 up to frame 18 the wiring of the tail warning radar is attached to the starboard wall together with power wiring; on frame 18 the radar wires are passed toward port side and run along port side wall to disjunction connector No.57 (WP-23).

Beginning from disjunction connector WP-23 the wiring is made of heat-proof wire ENBMS-0.75⁰ which is led together with power wiring. At frame 32 the wiring is passed into the fin to unit No.2 of radar SIRENA-2.

6. Radar Range Finder CPT-1M

Purpose

Radar range finder CPT-1M installed on aircraft MMT-190 is used for determining the target distance irrespective of visibility conditions.

Radar range finder CPT-1M provides for the search, lock-on and tracking of the target, for continuous automatic determination of target range as well as for supplying the computer of the ACH-5H sight (proportionally to distance).

Radar range finder CPT-1M used in conjunction with the ACH-5H sight, makes it possible to conduct aimed fire at airborne targets within the range of 300 to 2000 m., at an altitude of 2000 m. and higher.

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The radar range finder comes complete as follows:

1. Antenna (unit No.1).
2. Transceiver unit (unit No.2).
3. Range unit (unit No.3).
4. Supply unit (unit No.4).
5. Control desk (unit No.6).
6. Cables with range selector and target resetting button.

Arrangement of Units on Aircraft

Antenna (unit No.1) is mounted on the left side of the fuselage lower section, between frames 1 and 4.

The antenna is secured to the fuselage skin by three pins.

The antenna screen and fuselage skin must have a good electric contact, for which purpose the place of antenna installation is cleaned to bright metal.

The fuselage skin bears a hole to receive the antenna pipe union for connecting the cable from the transceiver (unit No.2).

Note: In aircraft of certain models the radar range finder antenna is installed on the outside of the accessories compartment cover between frames 1 and 3 along the aircraft fore-and-aft axis.

When at parking the aircraft antenna is covered by a red-painted metallic cover, easily removable.

Transceiver unit (unit No.2) is located in the upper accessories compartment, between frames 1 and 3, with the face panel toward frame 1. The transceiver unit is shock-mounted on the duralumin bracket riveted to the horizontal stiffener.

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The unit is so designed as to be removed without shock absorbers. For this, open two catch clips on the straps fastening the unit.

The transceiver unit is hardly accessible through the upper access hole since mounted above it is the transceiver of radio communications station PCMY-4. Therefore, to give access to the unit front panel a small hatch is provided in the right part of the air-intake duct (between frames 1 and 2).

Range unit (unit No.3) and supply unit (unit No.4) are in the cockpit, at frame 4 behind the instrument panel.

Both units are mounted on shock absorbers, type 271c, with the connectors toward starboard.

The units are easily removable.

They are fastened on the brackets rigidly connected to frame 4.

Access to the units is made possible only with the retractable and movable parts of the instrument panel thrown back.

Control desk (unit No.6) is installed in the cockpit, at frame 8, on the port side wall.

The control desk is bracketed on the beam fastening units Nos 5 and 8 of sight ACII-5HB3.

The control desk is rigidly mounted and offers a free access to the front panel and fastening screws.

Range selector is installed in the cockpit in the upper part of the port retractable board of the instrument panel above the gyro compass ГМК-1 indicator. The range selector is fastened with a box nut directly to the instrument panel. There are two inscriptions stencilled at the range selector: ALTITUDE OF RADAR RANGE FINDER OPERATION (ВЫСОТА РАБОТЫ СРД) and figures "2000 - 1200".

Test connector with stencilled mark RADAR RANGE FINDER - RECEIVER OUTPUT (СРД-1М. ВЫХОД ПРИЕМН.) is located below the instrument panel approximately along the aircraft fore-

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and-aft axis above the two-pointer pressure gauge.

The test connector is secured to the instrument panel with a box nut and is closed using a plug.

Target resetting button is installed in the cockpit at the left side, on the sight ACP-5H head.

The button is attached to the sheet duralumin bracket which is secured to the sight head with three screws.

Cemented above the button is the inscription TARGET RESETTING (СБРОС ЦЕЛИ).

All units are interconnected by coaxial cables and bunched conductors. Unit No.2 is coupled to the units located in the pressurized cockpit via a connector and adapter, both hermetically sealed. The adapter is installed at the left side of frame 4.

7. Bonding of Aircraft Parts and Installation of Static Dischargers

A. Bonding of Aircraft Parts

By bonding of aircraft parts we mean special electrical interconnection of aircraft metallic parts and various assemblies of the equipment with an object of maintaining a constant, reliable electric contact between them, with a small contact resistance. The quality of bonding is an important factor ensuring the reliable operation of radio aids and influencing the range of radio communication.

All aircraft metallic parts whose area exceeds 0.2 m^2 or whose length is more than 0.5 m. (bands, pipes, conduits), as well as all units and assemblies installed on the aircraft must have proper bonding with the aircraft structure.

Bonding of units and assemblies is accomplished either by filing the contacting surfaces or by means of bonding strips made of flexible brass braiding with lugs for fastening screws.

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One end of a bonding strip is attached to a unit or assembly, while the other, to the aircraft structure.

B. Installation of Static Dischargers

When flying at a high speed the aircraft gets considerably electrified due to the friction of air against the aircraft surface. Sometimes, certain parts of the aircraft develop potentials of several thousand volts.

Therefore, unreliable bonding may lead to electric dischargers, thereby causing interference with the operation of the aircraft radio aids.

Static electricity which is stored up on wing trailing edges swept by airflow is to be run off into atmosphere. For this purpose static dischargers are installed on wing tips, one on each outer wing panel.

The discharger is a metal tube to one end of which a threaded pin is riveted to screw the discharger into the wing tip. Into the other end of the tube a cotton folded wick is inserted.

The tube is filled with a compound (20 per cent of ethyl alcohol and 80 per cent of glycerine).

The compound is filled periodically, once a month.

8. Power Supply System

(Fig.26)

A. Main System

The radio stations are supplied with +28.5 V from the aircraft mains.

Radio altimeter PB-2, marker receiver MPH-48H, radio station SIRENA-2, radio station PCHV-4, radio compass ATK-5, the aircraft transponder and radio range finder CPA-1M are fed from bus-bar No.2 which is powered from the starboard power unit via circuit breaker ASC-30 (Ref.No.319).

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Radio compass APK-5, radio station PCWV-4 and the aircraft transponder are supplied with 115 V, 400 c.p.s. A.C. from inverter ИО-750 (Ref.No.2P).

The radio range finder is supplied with 115 V, 400 c.p.s. A.C. from inverter ИО-750 (Ref.No.17p).

High voltage for marker receiver МРП-48И is taken from radio compass receiver APK-5. To supply radio altimeter PB-2 with high voltage, converter PY-11AM is installed (included in the radio altimeter set).

Beside the main version of supply, there is an emergency version of supplying radio stations APK-5, МРП-48И, PCWV-4 and the transponder from inverter ИО-750 (Ref.No.17p). In this case the range finder will not operate.

Supply Circuits

(1) Radio altimeter PB-2 and marker receiver МРП-48И

The radio altimeter and marker receiver are supplied on switching on circuit breaker АЗС-5 (Ref.No.33P) installed on the starboard console and bearing the inscription PB-2, МРП.

A voltage of +28.5 V is fed via supply filter PB-2 to receptacle 27p from which the current is supplied to converter PY-11AM and PB-2 transceiver.

Simultaneously, the current passes via circuit breaker АЗС-5 (33p) to electric lamp 34p of marker receiver МРП-48И, to bell 28p and to marker receiver МРП-48И.

Receiver МРП-48И will operate only if the APK-5 radio compass receiver, supplying high voltage to receiver МРП-48И, is switched on. Therefore, to energize receiver МРП-48И, switch on radio compass APK-5.

(2) Tail warning radar SIRENA-2

To supply unit No.3 of radar SIRENA-2, cut in circuit breaker АЗС-5 (Ref.No.23p) inscribed SIRENA (СИРЕНА) and

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mounted on the starboard console. +28.5 V is fed to unit No.3 of radar SIRENA-2 via connector No.18.

(3) Radio compass APK-5, transponder and radio station PCWV-4

These are supplied on switching on circuit breaker АЗС-10 (Ref.No.3p) bearing the inscription RADIO, RADIO COMPASS, MARKER RECEIVER, TRANSPONDER, FLOWMETER (РАДИО, АРК, МРП, СРО, ПАСХОДОМЕР) which is mounted in the cockpit on the starboard console. To feed radio station PCWV-4, close switch 87K (1p) which is inscribed RADIO (РАДИО) and is mounted at the starboard console on the rear board alongside with circuit breakers.

To supply the radio stations with A.C., cut in circuit breaker АЗС-10 (3p), thereby passing the current via contacts 2-1 of ПИ-6 relay (5p) to terminal 4 of inverter ИО-750 (2p); the inverter is started being constantly supplied with +28.5 V from the starboard power unit.

Radio Compass APK-5

Switching on circuit breaker АЗС-10 (3p) sends +28.5 V current to terminal 19 of APK-15 control board (13p) via terminals 4-5 of ПИ-6 relay (5p) and fuse ЧИ-10 (35p).

At the same time the APK-5 control board is supplied with A.C. high voltage generated by inverter ИО-750 (2p) from inverter terminal No.6 via contacts 7-8 of ПИ-6 relay (5p) and fuse ЧИ-10 (8p).

Aircraft Transponder CPO

When switching on circuit breaker АЗС-10 (3p), +28.5 V D.C. is fed to the transponder control desk via terminals 4-5 of relay ПИ-6 (5p) and fuse ЧИ-10 (37p). A.C. current from inverter ИО-750 (2p) is also brought to the transponder control desk from terminal 6 via contacts 13-14 of ПИ-6 relay (5p) and fuse ЧИ-10 (6p).

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Radio Station PCWV-4
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Cutting in circuit breaker A3C-10 (3p) inscribed RADIO, RADIO COMPASS, MARKER RECEIVER, TRANSPONDER, FLOWMETER, with the RADIO (РАДИО) switch 87K (1p) found on the starboard console closed, makes the relay of radio set PH-2 (4p) operate and close its contacts 2-3.

+28.5 V is supplied from circuit breaker A3C-10 (3p) via contacts 4-5 of PH-6 relay (5p), fuse CH-10 (36p) and contacts 2-3 of PH-2 relay (4p) into the rectifier (unit B-1) of radio station PCWV-4 to terminal 5.

A.C. current from inverter NO-750 (2p) is supplied via terminals 10-11 of relay (5p), fuse CH-10 (7p) and contacts 5-6 of PH-2 relay (4p) to terminal 1 of rectifier B-1.

(4) Range finder CPT-1M

The range finder is one of the main loads; therefore it should be energized only in case a powerful supply source, like airborne batteries or generator, is available on the aircraft or on field.

Supplied from a powerful source, the +28.5 V current from terminal 2 of PHA-200A relay box, passes via terminals 17 of PH-6 relay (5p), to terminal 2 of the MP-1 relay (45H) cutting off the power loads and making the relay operate.

To energize the range finder, cut in circuit breaker A3C-10 (15p) located on the starboard console and inscribed RANGE FINDER (CPD).

+28.5 V D.C. is passed via contacts 4-3 of MP-1 relay (45H) to the range finder control desk. Simultaneously, the current from circuit breaker A3C-10 (15p) is supplied via the same contacts 4-3 of relay 45H to terminal 7 of PH-2 relay (21p), due to which the latter will operate, thereby closing its contacts 2-3 and 5-6. From contacts 6-5 of PH-2 relay (21p) and via contacts 4-5 of PH-2 relay (44H), the current will

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flow to terminal 4 of inverter NO-750 (17p) to feed the range finder and sight units with A.C. The inverter fed with +28.5 V from the starboard power unit will get started.

When switching on sight ACN-5H, inverter NO-750 (2p) will be started by the voltage applied to terminal 4 via contacts 6-5 of PH-2 relay (44H).

The current will pass from bus-bar 3 via circuit breakers A3C-20 (42H) and A3C-10 (1H).

The A.C. generated by the inverter will pass from inverter terminal 6 through fuse CH-10 (20p) and contacts 2-3 of PH-2 relay (21p) to the range finder control desk.

B. Emergency Supply System

In emergency cases, when inverter NO-750 (2P) fails, radio station PCWV-4, radio compass APK-5, marker receiver MPH-48H and the aircraft transponder will be powered by inverter NO-750 (17p) generally feeding A.C. to the range finder and sight units.

For this, cut in switch 87K (16p) which is installed in the cockpit on the starboard console and inscribed EMERGENCY SUPPLY RADIO, RADIO COMPASS, MARKER RECEIVER, TRANSPONDER, FLOWMETER (АВАРИЙНОЕ ПИТАНИЕ РАДИО, АРК, МРП, СРО, РАСХОДОМЕР).

Cutting-in of the switch (16p) makes the supply circuit of PH-6 relay winding (5p). The relay operates, its contacts 17-16 open and the supply circuit (from PHA-200A) of MP-1 relay winding (45H) becomes open. When relay 45H trips, its contacts 4-3 open and windings of two PH-2 relays (21p and 44H) become deenergized.

A voltage of +28.5 V is supplied via contacts 4-5 of relay 21p and 4-5 of relay 44H to terminal 4 of inverter NO-750 (17p), switching the latter on. Since the moment current is supplied to the winding of PH-6 relay (5p) its contacts 9-8, 12-11 and 15-14 become closed, the A.C. high voltage generated

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by the inverter will flow from terminal 6 via contacts 9-8 of PH-6 relay (5p) and fuse CH-10 (8p) to the control board of radio compass APK-5; via contacts 12-11, fuse CH-10 (7p) and contacts 5-6 of relay PH-2 (4p) (switch 1p being on) to the rectifier of radio station PCMY-4; and via contacts 15-14 and fuse CH-10(6p) to the transponder control desk.

At the same time the D.C. and A.C. supplies of the range finder and sight become cut off due to the opening of contacts 4-3, 8-7, and 12-11 of relay 45H, contacts 2-3 of relay 21p, and contacts 2-3 of relay 44H.

Chapter III INSTRUMENT EQUIPMENT General

The instrument equipment makes it possible to perform flight in the day and at night under conditions of zero visibility at high altitudes and under adverse weather conditions. The instrument equipment comprises:

1. Flight control and navigation instruments.
2. Power plant operation control instruments.
3. Instruments controlling operation of individual units and systems.

For convenience in conducting night flight all control knobs and levers are provided with luminous marking.

To free the pilot from the burden of memorizing figures and facilitate his operation the instruments scales are divided into coloured sectors indicating various operation conditions of the units:

- (a) blue sector - operation without limitations;
- (b) yellow sector - attention! Operation is permissible;
- (c) red sector - operation under these conditions is prohibited.

The instrument indicators are arranged on the instrument panel and in the port and starboard consoles and the cockpit side panels.

I. Arrangement of Instruments in Cockpit

The indicators, boards and control desks, switches and circuit breakers, valves and levers controlling aircraft

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systems and power plants, all elements of direct control and check up of units and equipment are arranged in the pilot's cockpit in the places convenient for observation and work.

1. Instrument Panel

As to its design instrument panel consists of panels and a welded tubular frame. The panels are one rigidly fixed panel and two shock-mounted panels.

The rigidly mounted portion of instrument panel frames the shock-mounted portion and, besides, is provided in its lower part with a projecting small panel. The rigidly mounted portion is screwed to fuselage frame 5.

The shock-mounted portion of instrument panel is arranged in the middle and consists of the left and right panels secured to the tubular steel frame shock-suspended to fixed portion of the instrument panel.

The left panel is collapsible with the view of providing an access to the instruments and equipment arranged behind the instrument panel.

The middle lower small panel of the instrument panel fixed portion is located below, in the centre, and is actually a dural panel fixed to the frame lower tube and the cockpit floor by means of a bracket.

Mounted on the fixed left portion are control and warning units. These are of the landing gear, lamps, flaps and air brakes.

Installed on the left-hand board, from top downwards are the following elements:

Type ПНН-45 change-over switch bearing the inscriptions: LANDING LAMP (ФАРА, ПОСАДОЧНАЯ), OFF (ВЫКЛЮЧЕНО), TAXIING LAMP (РУЛЕВНАЯ).

The ПНС-2 flight and landing control board mounting three landing gear extension green lamps; three landing gear

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retraction red lamps; flaps extension green warning lamp marked FLAPS EXTENDED (ЗАКРЫЛКИ ВЫПУЩЕНЫ); air brakes extension green warning lamps marked AIR BRAKES EXTENDED (ШТКИ ВЫПУЩЕНЫ); red warning lamp marked EXTEND LANDING GEAR (ВЫПУСТИ ШАССИ); night flight light intensity control shutter and warning lamps control button marked LAMP CONTROL (КОНТРОЛЬ ЛАМП).

Landing gear change-over switch with inscriptions: LANDING GEAR (ШАССИ), UP (УБРАНО), DOWN (ВЫПУЩЕНО).

Oxygen indicator, type МК-18.

Arranged on the starboard fixed portion of the instrument panel are:

Fuse marked LANDING AND TAXIING LAMPS FUSE (ПРЕДОХРАНИТЕЛЬ ФАР).

Cabin altitude and pressure indicator, type УВПД-15.

Pressure gauge M-1000.

Mounted below, in the middle portion of the instrument panel are bombing equipment controls, ammunition rounds counter and other pieces of equipment (see from left to right and upwards):

2Б-45 switch marked TACTICAL RELEASE (ТАКТИЧЕСКИЙ СЕРОС) and ARMED (ВКЛЮЧЕН НА ВЗРЫВ).

Three ammunition rounds counters 3-M-005 marked PORT CANNON (ОРУЖИЕ ЛЕВОЕ), MIDDLE (СРЕДНЕЕ), STARBOARD (ПРАВОЕ).

Warning red lamps marked ARMED (ВЗРЫВ).

Two СЛЦ-51 warning green lamps marked BOMBS SUSPENDED (ПОДВЕСКА БОМБ).

МГ-250 pressure gauge.

СЛЦ-51 warning red lamp marked SUSPENDED TANKS (ПОДВЕСЕННЫЕ БАКИ).

Two-pointer pressure gauge for 12 kg/cm².

Installed on the shock-mounted port panel of the instrument panel (see from top downwards and from left to right) are flight control and navigation instruments.

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PB-2 radio altimeter indicator.
 ВД-20 altitude indicator.
 5K matching knob of ГПК-1 compass.
 СРД-1M station range switch marked RADAR RANGING UNIT
 PERFORMANCE ALTITUDE (ВЫСОТА РАБОТЫ СРД), 12,000 m. (12,000 m),
 2000 m. (2000 m).
 Indicator of ГПК-1 gyro induction compass and АПК-5
 radio compass.
 KVC-2000 speed indicator.
 Aircraft clock.
 Warning lamp of pressure control in main and booster
 hydraulic systems.
 Knob 5K marked ARM LAMP CONTROL (КОНТРОЛЬ ЛАМПЫ ПЛЕЧА).
 СЛЦ-51 warning red lamp labelled MARKER (МАРКЕР).
 СЛЦ-51 warning green lamp marked LAMP OFF DURING LANDING,
 USE HAND CONTROL (НА ПОСАДКЕ ЛАМПА НЕ ГОРИТ, ПЕРЕХОДИ НА
 РУЧНОЕ УПРАВЛЕНИЕ).
 АРУ-2A unit arm position indicator marked STABILIZER
 (СТАБИЛИЗАТОР).
 Gyro horizon АГН-1.
 Turn indicator ЗУН-53.
 СЛЦ-51 warning green lamp marked STABILIZER TRIM TAB
 EFFECT NEUTRAL (ТРИММЕРНЫЙ ЭФФЕКТ НЕЙТРАЛЬНО).

Note: The arrangement of instruments on the starboard
 shock-mounted portion of the instrument panel
 given in the present Description corresponds to
 their arrangement in the aircraft beginning from
 production series 7-51 on.

The arrangement of instruments on the port
 shock-mounted portion of the instrument panel in
 the aircraft of production series up to 7-51 as
 compared with their arrangement in aircrafts of
 further production series was as follows:

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PB-2 radio altimeter indicator occupied the
 place of ВД-20 altimeter.
 ВД-20 altimeter occupied the place of KVC-2000
 speed indicator.
 ГПК-1 indicator was mounted where PB-2 radio
 altimeter is now located.
 Speed indicator occupied the place of ГПК-1
 indicator.

Installed on the starboard shock-mounted portion of the
 instrument panel are: flight control and navigation instru-
 ments, power plant, performance control instruments and
 generators' performance control lamps (see from top down-
 wards and from left to right).

Two СЛЦ-51 warning red lamps marked: LEFT (ЛЕВЫЙ),
 RIGHT (ПРАВЫЙ), and STARTED IN AIR, IGNITION OFF (ЗАПУСК В
 ВОЗДУХЕ ПРОИЗВЕД, ЗАЖИГАНИЕ ВЫКЛЮЧИ).

Variometer ВАР-150 (or ВАР-300).

Indicator, type M-1.5.

Tachometer 2ТЭ-15-1.

Exhaust gases thermometer 2ТБТ-411.

TP3-52 fuel quantity gauge and flowmeter indicator.

T-6 warning board mounting: two СЛЦ-51 green warning
 lamps marked AFTERBURNING (ФОРСАЖ); two СЛЦ-51 red warning
 lamps marked OIL USED UP (НЕТ МАСЛА); first kerosene tank
 pump breakdown warning lamp СЛЦ-51 marked 1st TANK (1-й БАК);
 СЛЦ-51 red lamp signalling of fuel remainder marked 550 LITRES
 LEFT (ОСТАЛОСЬ 550 ЛИТРОВ); lamps checking button marked
 LAMPS CONTROL (КОНТРОЛЬ ЛАМП).

Two СЛЦ-51 orange warning lamps marked LEFT GENERATOR
 OFF (ЛЕВЫЙ ГЕНЕРАТОР ВЫКЛЮЧЕН) and RIGHT GENERATOR OFF
 (ПРАВЫЙ ГЕНЕРАТОР ВЫКЛЮЧЕН).

Voltmeter В-1.

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2. Port Console

The port console is mounted on the cockpit port side panel and comprises detachable horizontal and vertical panels fixed to the frame by means of screws.

Arranged on the port console are control units of the power unit, fuel system, APV-2A automatic equipment, rocket system and other equipment.

The console vertical panel mounts (if viewed from the instrument panel backward) as follows:

Elements used to control and check the power unit and fuel system for performance. These are:

A3C-5 circuit breaker marked 1st TANK PUMP (НАСОС 1-го БАКА).

ASP-15 circuit breaker marked 2nd TANK PUMP (НАСОС 2-го БАКА).

ASP-10 circuit breaker marked 3rd TANK PUMP (НАСОС 3-го БАКА).

ASP-10 circuit breaker marked 4th TANK PUMP (НАСОС 4-го БАКА).

СЛН-51 green warning lamp which lights up when pressure built by the second tank pump is less than 0.3 kg/cm².

СЛН-51 green warning lamp which lights up when pressure built by the third or fourth tank pumps is less than 0.3 kg/cm².

Button 205K marked FIRE EXTINGUISHER (ОГНЕТУШИТЕЛЬ) covered with protective cap.

СЛН-51 red warning lamp marked FIRE (ПОЖАР).

Buttons 204K provided with protective caps marked SHUT OFF COCK (ПЕРЕКРЫВНОЙ КРАН), LEFT-CLOSED (ЗАКР.ЛЕВЫЙ), RIGHT-CLOSED (ЗАКР.ПРАВЫЙ).

Switches 88K marked AIRBORNE IGNITION (ЗАЖИГАНИЕ В ВОЗДУХЕ), PORT (ЛЕВЫЙ), STARBOARD (ПРАВЫЙ).

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A3C-5 circuit breakers marked WHEEL BRAKES AUTOMATIC CONTROL UNIT (АВТОМАТ ТОРМОЗОВ КОЛЕС).

A3C-5 circuit breakers marked COCKPIT SUPPLY (ПИТАНИЕ КАБИНЫ), ELECTRIC TURN INDICATOR (ЭУП); DE-ICER (ПРОТЯВО-ОБЛЕДЕНИТЕЛЬ), LEFT REAR COCKPIT LAMP (КАБИН. ЛАМПА - ЛЕВАЯ ЗАДНЯЯ).

A3C-5 circuit breaker marked STARTING UNITS (АППАРАТЫ ЗАПУСКА).

A3C-5 circuit breaker marked ENGINE INSTRUMENTS (ПРИБОРЫ ДВИГАТЕЛЯ), FIRE EXTINGUISHING EQUIPMENT (ПРОТИВО-ПОЖАРНОЕ ОБОРУДОВАНИЕ), 1st, 3rd, 4th TANKS PUMP SIGNAL (СИГНАЛ ПМПЫ 1, 3, 4 БАКОВ).

A3C-5 circuit breaker marked SHUT OFF COCK, (ПЕРЕКРЫВ-НОЙ КРАН), RIGHT ENGINE OIL PRESSURE (ДАВЛЕНИЕ МАСЛА ПРА-ВОГО ДВИГАТЕЛЯ).

A3C-5 circuit breaker marked SHUT OFF COCK (ПЕРЕ-КРЫВНОЙ КРАН), LEFT ENGINE OIL PRESSURE (ДАВЛЕНИЕ МАСЛА ЛЕВОГО ДВИГАТЕЛЯ).

A3C-5 circuit breaker marked RIGHT ENGINE AFTERBURNING AND MAXIMUM RATINGS EMERGENCY CONTROL (АВАРИЙНОЕ ОТКЛЮЧЕНИЕ ФОРСАЖА МАКСИМАЛА ПРАВОГО ДВИГАТЕЛЯ).

A3C-5 circuit breaker marked LEFT ENGINE AFTERBURNING AND MAXIMUM RATINGS EMERGENCY CONTROL (АВАРИЙНОЕ ОТКЛЮЧЕНИЕ ФОРСАЖА МАКСИМАЛА ЛЕВОГО ДВИГАТЕЛЯ).

Stabilizer and APV-2A Controls

ПН-45 APV switch marked BIG ARM (БОЛЬШОЕ ПЛЕЧО) and SMALL ARM (МАЛОЕ ПЛЕЧО).

88K APV switch marked AUTOM. (АВТОМ.) and MANUAL (РУЧНОЕ).

C-5 Unit Controls

Button 204K marked ROCKET EMERGENCY JETTISONING (АВА-РИЙНЫЙ СБРОС РС).

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Switch ПНН-45 marked 1 SALVO (1 ЗАЛП), AUTOM. (АВТОМАТ), 4 SALVOES (4 ЗАЛПА).

C-5 unit control board which mounts eight white lamps (signalling of number of rounds left), green lamp (signalling of readiness for firing), red lamp (signalling of rounds used up), lamp brightening switch marked DAY-NIGHT (ДЕНЬ-НОЧЬ), button marked CONTROL (КОНТРОЛЬ) and sockets to plug in a special ohmmeter.

Some Controls of Sight, Radar Ranging Unit,
Signal Flare Pistol and Other Equipment

Signal flare board mounting switch B-45 marked SIGNAL FLARES (СИГНАЛЬНЫЕ ПАКЕТЫ), SWITCHED OFF (ВЫКЛЮЧЕНО) and SWITCHED ON (ВКЛЮЧЕНО) and four coloured buttons.

Radar ranging unit and АРН-5H sight combined control desk.

Button 204K underprotected by cap and marked PARACHUTE RELEASE (СБРОС ПАРАШЮТА).

Button of РСНУ-4 station set marked ALARM (ТРЕВОГА).

Switch of АРК-5 radio compass marked "150-310", "310-640", "640-1300".

Board ДУ-2 of КИ-30 oxygen apparatus remote control.

Oxygen apparatus КИ-30.

Ultra violet lamp fixtures.

Mounted on the horizontal portion of port console

(Viewing from the instrument board backward) are:

РСНУ-4 station control board.

Switch 38K marked STABILIZER CONTROL (УПРАВЛЕНИЕ СТАБИЛИЗАТОРОМ), TURN ON HYDRAULIC CONTROL SYSTEM (ВКЛ. ГИДРОУПРАВЛЕНИЕ) and SWITCH ON ELECTRIC CONTROL SYSTEM (ВКЛ. ЭЛЕКТРОУПРАВЛЕНИЕ).

Switch ПНН-45 marked AILERON TRIM TAB (ТРИММЕР ЭЛЕРОНА), RIGHT (ПРАВО), LEFT (ЛЕВО).

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Switch 88K marked AILERON BOOSTER (ГИДРОУСИЛИТЕЛЬ ЭЛЕРОНА) and SWITCHED ON (ВКЛЮЧЕНО).

Throttle control sector marked: STOP (СТОП), LOW THROTTLE (МАЛЫЙ ГАЗ), NORMAL THROTTLE (НОМИНАЛ), MAXIMUM (МАКСИМАЛ), AFTERBURNING (ФОРСАЖ).

Flap control board mounting three buttons marked FLAPS (ЗАКРЫЛКИ), TAKE-OFF (ВЗЛЕТ), LANDING (ПОСАДКА) and RETRACTED (УБРАНЬ).

Two buttons 204K protected by a cap and marked START (ЗАПУСК), PORT (ЛЕВЫЙ) and STARBOARD (ПРАВЫЙ).

Three-position switch ПЭПН-20 marked АНО (navigation lights), "10%", "30%", and "100%".

Besides, mounted here are airspeed tube shut-off cock, automatic pressure unit АД-5 and shut-off valve KB-2M of ККО-1 system.

3. Starboard Console

Arranged on the panels and boards of the starboard console are circuit breakers and controls of radio equipment, electric equipment, gunnery, photo-camera controller as well as air and hydraulic system pressure gauges.

Mounted on the vertical panel of the starboard console (if viewed from the instrument panel backward) are the following switches and circuit breakers:

Switch 87K marked AIRBORNE BATTERY, GROUND BATTERY (АККУМУЛЯТОР БОРТОВОЙ; АЭРОДРОМНЫЙ).

Switch 87K marked RADIO EMERGENCY SUPPLY, RADIO COMPASS, MARKER RECEIVER, I.F.F. TRANSPONDER, FUEL QUANTITY GAUGE AND FLOWMETER (АВАРИЙНОЕ ПИТАНИЕ РАДИО, АРК, МРП, СРО, ПАСХОДОМЕР).

Circuit breaker АЗС-10 marked RADIO, RADIO COMPASS, MARKER RECEIVER, I.F.F. TRANSPONDER, FUEL QUANTITY GAUGE AND FLOWMETER (РАДИО, АРК, МРП, СРО, ПАСХОДОМЕР).

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Circuit breaker A3C-5 marked PB-2 RADIO ALTIMETER and MARKER RECEIVER (PB-2 and МРП).

Circuit breaker A3C-5 marked TAIL WARNING RADAR (СИРЕНА).

Circuit breaker A3C-5 marked AILERON TRIM TAB, TRIM TAB EFFECT (ТРИММЕР ЭЛЕРОНА, ТРИММЕРНЫЙ ЭФФЕКТ).

Circuit breaker A3C-5 marked MVC-2 STABILIZER CONTROL (УПРАВЛЕНИЕ MVC-2 СТАБИЛИЗАТОРА).

Circuit breaker A3C-5 marked АГВ-1 GYRO HORIZON EMERGENCY SUPPLY (АВАРИЙНОЕ ПИТАНИЕ АГВ-1).

Circuit breaker A3C-10 marked ГИК-1 (gyro induction compass) and АГВ-1 (gyro horizon).

Two circuit breakers A3C-10 marked AIRSPEED TUBE CLOCK (ПВД, ЧАСЫ), EMERGENCY ТН-156 (АВАРИЙНОЕ ТН-156), SWITCH ON ONLY PRIOR TO TAKE-OFF, SWITCH OFF JUST AFTER LANDING (ВКЛЮЧАТЬ ТОЛЬКО ПЕРЕД ВЫЕТОМ, ВЫКЛЮЧАТЬ СРАЗУ ПОСЛЕ ПОСАДКИ).

Switch 2B-45 marked PORT GENERATOR (ГЕНЕРАТОР ЛЕВЫЙ).

Switch 2B-45 marked STARBOARD GENERATOR (ГЕНЕРАТОР ПРАВЫЙ).

Circuit breaker A3C-10 marked ROCKETS (РС).

Circuit breaker A3C-20 marked SIGHT HEATER, SIGHT (ОБОГРЕВ ПРИЦЕЛА, ПРИЦЕЛ).

Circuit breaker A3C-10 marked SIGHT (ПРИЦЕЛ).

Circuit breaker A3C-10.

Three circuit breakers A3C-10 marked CANNONS, PORT, MIDDLE, STARBOARD (ПУШКИ, ЛЕВАЯ, СРЕДНЯЯ, ПРАВАЯ).

Circuit breaker A3C-5 marked PHOTO-CAMERA CONTROLLER (ФКП).

Circuit breaker A3C-5 marked PHOTO-CAMERA CONTROLLER BUTTON (КНОПКА ОРУЖИЯ, ФКП).

Circuit breaker board mounting:

Circuit breaker A3C-25 marked LANDING AND TAXIING LAMPS (ФАРЫ).

Circuit breaker A3C-5 marked АРУ-2А CONTROL (УПРАВЛЕНИЕ АРУ-2А).

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Three circuit breakers A3C-10 marked ARMED-SAFE (ВЗРЯВ-НЕВЗРЯВ), BOMBS (БОМБЫ), BOMB EMERGENCY RELEASE (АВАРИЙНЫЙ СБРОС БОМБ), TANK JETTISONING (СБРОС БАКОВ).

Switch 87K marked RADIO (РАДИО).

Circuit breaker A3C-5 marked LANDING GEAR WARNING SYSTEM (СИГНАЛИЗАЦИЯ ШАССИ), AIR BRAKES (ТОРМОЗНЫЕ СИСТЕМЫ), NAVIGATION LIGHTS (АНО).

Circuit breaker A3C-5 marked (АРУФОН), PORTABLE LAMP (ПЕРЕНОСНАЯ ЛАМПА), FLARES (ПАКЕТЫ).

Circuit breaker A3C-5 marked LANDING GEARS (ШАССИ), FLAPS (ЗАКРЫЛКИ), PARACHUTE (ПАРАШЮТ).

Circuit breaker A3C-5 marked STABILIZER BOOSTER (БУ СТАБИЛИЗАТОРА), AILERON BOOSTER (БУ ЭЛЕРОНА).

Control boards and other equipment:

Control board of radio compass АРК-5.

Electric bell МРП-48П.

Map holder.

Three rheostats РУФО-45 marked LEFT (ЛЕВАЯ), RIGHT (ПРАВАЯ), SIDE (БОКОВАЯ).

Switch ПЭПН-20 marked СОСКРИТ HEATER (ОБОГРЕВ КАБИНЫ), AUTOMATIC (АВТОМАТ), HOT (ГОРЯЧИЙ), COLD (ХОЛОДНЫЙ).

Mounted on the horizontal portion of the starboard

console are air and hydraulic systems pressure gauges (if viewed from the instrument panel backward).

80-kg/cm² pressure gauge marked LANDING GEAR EMERGENCY AIR BOTTLE, 50 kg/cm² (АВАРИЙНЫЙ БАЛЛОН ШАССИ 50 кг/см²).

250-kg/cm² pressure gauge marked MAXIMUM PRESSURE IN HYDRAULIC SYSTEM - 140 kg/cm² (МАКСИМАЛЬНОЕ ДАВЛЕНИЕ В ГИДРОСИСТЕМЕ 140 кг/см²).

250-kg/cm² pressure gauge marked FLAP EMERGENCY AIR BOTTLE, 130 kg/cm² (АВАРИЙНЫЙ БАЛЛОН ЗАКРЫЛКОВ 130 кг/см²).

250-kg/cm² pressure gauge marked MAIN BOTTLE, 150 kg/cm² (ОСНОВНОЙ БАЛЛОН 150 кг/см²).

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Landing gear and flaps emergency control valves

Landing gear emergency valve.

Flaps emergency valve.

4. Instruments Installed above the Instrument Panel

Installed above the instrument panel under the canopy visor on the fuselage are:

Overcharge board marked OVERCHARGE (ПЕРЕЗАРЯДКА), LEFT, MIDDLE, RIGHT (ЛЕВАЯ, СРЕДНЯЯ, ПРАВАЯ).

Button 205K protected with a cap marked BOMB EMERGENCY JETTISONING, TANK JETTISONING (АВАРИЙНЫЙ СБРОС БОМБ, СБРОС БАКОВ).

Switch ПН-45 marked HOMING (ПРИВОДНЫЕ), OUTER (ДАЛЬНИЙ), INNER (БЛИЗКИЙ).

Button 204K protected with a cap marked BRAKE PARACHUTE (ТОРМОЗНОЙ ПАРАШЮТ).

I.P.P. transponder destruction button marked DESTRUCTION CIRCUIT CONTROL (ВЫКЛ. ЦЕПИ ВЗРЫВА) and DESTRUCTION (ВЗРЫВ).

Vertical load factor indicator AM-10.

Installed in the cast electronic unit are:

ACH-5H sight head and valve УП-33 marked FRONT WHEEL BRAKE, ON, OFF (ТОРМОЗ ПЕРЕДНЕГО КОЛЕСА, ВКЛЮЧЕНО, ВЫКЛЮЧЕНО) and target reset button of СРД-1M radar ranging unit set.

II. Flight Control and Navigation Instruments

The flight control and navigation instruments include:

1. Combined speed indicator КВС-2000.
2. Undisturbed gyro horizon АГН-1.
3. Gyro induction compass ГИК-1.
4. Two-pointer altimeter ВД-20.
5. Electrical turn indicator ЗУП-53.
6. Aircraft clock АЧХ.

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7. Variometer BAF-150 (the aircraft of the ninth production series and on are equipped with BAF-300).

8. Arm position indicator of АРУ-2А; В-1.

9. Machmeter М-1.5.

10. PB-2 radio altimeter.

11. Accelerometer AM-10.

The flight control and navigation instruments enable the pilot to properly employ in flight the flight technical characteristics of the aircraft and to conduct orientation by the assigned course.

One part of the flight control and navigation instrument is operated by the air speed tube ПВД-4 system on the principle of measuring dynamic and static pressure in flight and the other part is based on radio, electrical and hyroscopic gyro principles of operation.

1. Combined Airspeed Indicator КВС-2000

Purpose

The combined airspeed indicator КВС-2000 is intended for measuring the I.A.S. (indicated airspeed) ranging from 150 to 1600 km/hr and T.A.S. (true airspeed) ranging from 400 to 2000 km/hr, at flight altitudes ranging from 0 to 20 km., I.A.S. changing from 400 to 1600 km/hr.

Principle of Operation

The instrument action is based upon measuring dynamic pressure, i.e. difference between the impact and static pressure in flight, the method-of-measurement correction for air density, according to altitude values, introduced.

While designing and calibrating the instrument use was made of theoretical dependence between static and dynamic pressure and T.A.S., both for subsonic and supersonic speeds.

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with due allowance for air compression. The instrument method of-measurement error depends on the actual temperature deviation from the standard one and is determined by the formula:

$$\frac{\Delta V}{V} = \sqrt{\frac{T_H}{T}} - 1 \quad (1)$$

where: ΔV = difference in instrument readings and T.A.S.;
 T_H = temperature at altitude H according to ISA (International Standard Atmosphere);
 T = actual temperature at the same altitude.

The quantitative estimation of the method used for measuring error can be obtained by formula (I), the value of error depending on climate, season and time of day.

Brief Technical Data

1. The instrument operates at ambient temperature ranging from $+50^{\circ}\text{C}$ to -60°C .
2. T.A.S. reading error at a standard temperature at altitude ranging from 0 to 20 km. do not exceed values given in Table 1.

Table No.1

Altitude, km.	Tolerable errors, km/hr
0; 4	± 60
8; 12	± 75
14	$\pm 60^x$
16; 20	± 100

^{x/} The error at an altitude of 14 km. spreads over to speeds ranging from 900 to 1000 km/hr.

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3. I.A.S. reading errors at a standard temperature do not exceed values listed in Table No.2.

Table No.2

Scale marks to be checked, km/hr	Tolerable errors, km/hr
200, 300, 400	± 10
600, 800	± 20
1000, 1200	± 25
1400, 1600	± 25

4. The instrument reading variation at a standard temperature at an altitude of 0 km. does not exceed instrument error tolerable values indicated in Table No.2.

5. The instrument dynamic system is airtight, provided the pressure values correspond to a speed of 1600 km/hr at an altitude of 0 km.

6. The instrument housing is sealed in such a way that with rarefaction corresponding to T.A.S. readings of 1300 km/hr, the pointer will shift not more than 40 km/hr for 1 min.

7. The instrument withstands overload pressure corresponding to a speed of 1700 km/hr at an altitude of 0 km. for 1 min.

8. The instrument is vibration-proof within frequency ranging from 10 to 80 c.p.s. with vibration acceleration up to 1.1 g, vibration amplitude not exceeding 0.5 mm.

9. The instrument is shock-resistant at vibrations which lie within 25 - 90 c.p.s., with vibration acceleration not exceeding 1.1 g.

10. Instrument weight (without mounting parts) does not exceed 1000 gr.

Delivery List

The instruments set includes:

(a) KVC-2000 speed indicator, only 1 piece

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- (b) Screw BД-20-118 4 pieces
 (c) Cap BД-20-116 2 pieces
 (d) Certificate 1 copy

2. Undisturbed Gyro Horizon АГН-1

Purpose and Specifications

The gyro horizon АГН-1 performs the following functions:

1. It is used to check the aircraft for roll and pitching during level flight with an accuracy of up to 1° .
2. It is used to check all types of aircraft evolutions - banked turns (the degree of bank being unlimited) wing-overs, cabrage and dive (the degree of pitch angle being unlimited) and other evolutions with an accuracy of up to 3° .
3. Determines the aircraft position in space by roll (through $\pm 360^{\circ}$) and pitching (through $\pm 360^{\circ}$) in case the pilot will lose space orientation, the accuracy of pitch and roll determination being up to 3° .
4. Determines the aircraft angle of attack during the level flight.
5. The gyro horizon enables the pilot to roughly conduct orientation by pitching and roll when he should estimate his position in space and perform some evolutions by pitching or roll with high degree of accuracy at the same time.

3. Gyro Induction Compass ГМК-1

Purpose

The electric remote control gyro induction compass ГМК-1 operating in conjunction with the radio compass АРК-5 is designed for determining magnetic course, angles of turn, homing station relative bearings required for forming box pattern during instrument landing, magnetic radio bearing (direct and reverse) of the homing station as well as for

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facilitating the aircraft landing by instruments, for carrying flights towards the radio station and from it and memorizing angles of drift.

Basic Specifications

1. The compass starts to operate after cutting-in within 1 min. at $+20^{\circ}\text{C}$ and $+50^{\circ}\text{C}$ and in 3 minutes at -60°C .
2. The compass error by magnetic course does not exceed $\pm 2.5^{\circ}$.
3. Post-turn error does not exceed 0.5° per each min. of turn.
4. Error in indication of homing station magnetic bearing $\pm 3.5^{\circ}$.
5. Temperature range. The compass trouble-free operation is ensured:
 - (a) when staying at an ambient temperature ranging from $+50^{\circ}$ to -60°C for a long period of time;
 - (b) when all compass components stay at an ambient temperature of $+60^{\circ}\text{C}$ for 15 min.;
 - (c) when the transmitter stays at an ambient temperature of $+90^{\circ}\text{C}$ for 5 min.
6. The compass operates at all altitudes up to 20,000 m.

Delivery List

The ГМК-1 compass set includes:

- | | |
|----------------------------------|---------|
| 1. Variable indicator ВД | 1 piece |
| 2. Gyro-unit Г-3 | 1 piece |
| 3. Correction mechanism КМ | 1 piece |
| 4. Amplifier У-6М | 1 piece |
| 5. Junction box СК-11 | 1 piece |
| 6. Indicator УІР-1 | 1 piece |
| 7. Matching button 5К | 1 piece |

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PNK-1 Compass Arrangement
.....

The compass components are mounted in the following places of the aircraft:

Gyro-unit T-3, amplifier Y-GM and junction box CK-11 in the front lower bay, to the left, between frames 5 and 6;

Indicator YTP-1 and matching button 5K in the left upper portion of the instrument panel.

The indicator is integral with the APK-5 radio compass indicator. The correction mechanism is mounted behind the instrument panel, in the middle part of frame 4. Variable indicator WD is located in the fin. The gyro induction compass PNK-1 operates in conjunction with correction switch BK-53 installed below, to the left on framing 9.

The compass PNK-1 is fed by converter HT-125, mounted below under the cockpit floor on framing 9 at the starboard.

To eliminate the PNK-1 transmitter initial error when mounting it after dismantling, match the transmitter scale index mark 0 with the pointer on the diaphragm in the transmitter bay, in the fin. (The pointer was introduced beginning from production series 6-II).

4. Two-Pointer Altimeter BA-20Purpose
.....

Two-pointer altimeter BA-20, range 20 km., is mounted on the instrument panel. It is used for determining the aircraft flight relative altitude (relative to the take-off or landing ground).

The instrument is based on measuring the static atmospheric pressure in flight.

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Brief Specifications
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Its altitude measuring range is from 0 to 20,000 m. The housing airtightness is ensured at rarefaction corresponding to 5000 m. of altitude as seen on the instrument scale, the pointer deflection not exceeding 100 m. per 1 min. With the pointer set at zero and the pressure in the housing equal to 760 mm of mercury, the barometric altitude readings will differ from 760 mm of mercury not more than by 2 mm of mercury and the movable index readings will deviate from zero not more than by ± 10 m.

The error of the instrument readings at a temperature of $+20^{\circ}\pm 5^{\circ}\text{C}$ does not exceed values given in the Table below.

Scale marks, m.	Instrument error, m.	Scale marks, m.	Instrument error, m.
0	± 20	12,000	± 180
500-2000	± 50	14,000	± 200
4000	± 70	16,000	± 250
6000	± 90	18,000	± 300
8000	± 130	20,000	± 350
10,000	± 150		

5. MachmeterPurpose
.....

The machmeter is used for measuring flight true air speed relative to the speed of sound, i.e. Mach number, its value ranging from 0.6 to 1.5 at altitudes of 0 to 16 km.

Principle of Operation
.....

The principle of the instrument operation is based upon measuring the difference between impact and static pressures

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in flight, i.e. velocity head (dynamic pressure) with using correction for air density being introduced by means of an aneroid.

Either an airspeed tube or pitot tube (impact pressure tube) may be used as a pressure head, its principle of operation and design being identical with combined airspeed indicator (KX).

Basic Specifications

1. The instrument operates at an ambient temperature ranging from +50°C to -60°C.
2. The tolerable errors of the instrument at a standard temperature are listed in the Table below.

Values to be checked against scale (Mach number)	Altitude, km.	Tolerable error (Mach number)
Numbered scale marks	0	±0.02
From 0.9 to 1.0	4, 8, 12 and 14 16	± 0.02 ± 0.03
From 0.6 to 0.8 and from 1.1 to 1.5	4 and 8 12, 14 and 16	± 0.06 ± 0.08

3. The pointer jerky movement of up to 2 mm along the scale arc at a normal temperature is tolerable, the measured value being changed smoothly.

4. The instrument airtightness meets the following requirements:

(a) for the static system with the rarefaction in the housing corresponding to instrument reading of 1.5 Mach number, the pointer drop deflection should not exceed one scale division per min.;

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(b) The dynamic system, with pressure values corresponding to the instrument maximum reading is airtight.

6. Variometer BAP-150

Purpose

The aircraft variometer, range 0 - 150 m.p.s. indicates climb or descent speed. The variometer is mounted on the instrument panel.

The action of the instrument is based on the pressure variation lag in the instrument air-tight housing communicating with the atmosphere through a glass capillary tube relative to the pressure variation in the pressure gauge box directly communicating with the atmosphere.

Basic Specifications

1. Instrument errors at a standard temperature are given in the Table below.

Marks by scale	Permanent error, m.p.s.
0	+1
10-20	+2
30	+3
50	+5
70-100	+8
150	+10

2. The pointer deflection from the zero mark at a standard temperature should not exceed ±1 m.p.s.

3. The pointer jerky movement, with the value measured changing smoothly, at a standard temperature should not exceed 2 mm along the scale arc.

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4. The instrument static system is sealed in such a way that with rarefaction equal to 380 mm of mercury the rarefaction drop does not exceed 2 mm of mercury per 1 min.
5. The instrument withstands overload pressure corresponding to a speed of 550 m.p.s. for 1 sec.
6. The instrument operates within temperature ranges of 50°C to -60°C.

7. Aneroido-Diaphragm Instruments and Airspeed

Tube HBA-4 and Pitot Tube TH-156

General

Aneroido-diaphragm instruments in the aircraft are included into the general system of static pressure and the system of impact pressure of airspeed tube HBA-4.

The aneroid instruments' system key diagram is presented in Fig. 37.

The main airspeed tube HBA-4 with an electric heater adjusted for 27 V $\pm 10\%$ is installed on the peak in the nose and serves to take the impact pressure (static pressure + dynamic pressure) occurring during the aircraft movement and separately static pressure.

Besides there is emergency impact pressure pitot tube TH-156.

Basic Specifications

Characteristic	Tolerable values
Airtightness:	
(a) dynamic chamber	Pressure drop - not
at 760 mm of mercury	over 5 mm of mercury for
(b) static chamber at	3 min.
370 mm of mercury	

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Characteristic	Tolerable values
- Current drawn by electric heater element	At 27 V - 7.5 - 8.5 A
- Air consumption when supplying at pressure of 100 mm	Within 2 - 15 lit/m.

Installation of Emergency Pitot Tube TH-156

To provide reliable supply of the dynamic pressure the aircraft is equipped with duplicating emergency pitot tube TH-156 mounted at frame 3 near the starboard just where the upper hatch cover is jointed with the side panel.

For switching over the dynamic line the port console (in the cockpit) mounts manual shut-off cock adjusted for two positions: HBA-4 OPERATING (HBA-4 PAE.) and TH-156 EMERGENCY (TH-156 ABAP.).

In case the HBA-4 airspeed tube fails, the pilot employs the shut-off cock to feed instruments with pressure from pitot tube TH-156.

The static and dynamic line is provided with moisture collectors. The TH-156 pitot tube heater is controlled by means of ASC-10 circuit breaker mounted on the starboard console.

8. Electrical Turn Indicator AVI-53

The electrical turn indicator is used to determine the rate of turn of an aircraft about the vertical axis and its side-slip.

This instrument serves to indicate the straightness of the flight according to the ball position in the instrument centre.

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Brief Specifications

1. The instrument is fed with D.C. voltage of 27 V $\pm 10\%$.
2. With the voltage changing within ± 10 per cent the instrument sensitivity and errors should meet the following requirements:

Instrument sensitivity during flat turn with the angular velocity equalling $0.6^\circ/\text{sec.} - 4^\circ \pm 2^\circ$ and with angular velocity equalling $1.5^\circ/\text{sec.} - 12^\circ \pm 2^\circ$.

Instrument error during banks equalling 15° , 30° and 45° with angular velocity of $1^\circ/\text{sec.}$, $2.3^\circ/\text{sec.}$ and $4^\circ/\text{sec.}$ respectively - does not exceed $\pm 1.5^\circ$.

3. The movable index drag angle should not exceed $\pm 1.5^\circ$ when the instrument is in operation.

4. The current consumed does not exceed 0.13 A.

9. Arm Position Indicator of APV Variable Ratio
Boost Control Unit

Purpose

The arm position indicator of APV variable ratio boost control unit is intended to check the APV-2A rod position according to flight altitude and speed in conformity with the adjustment law of the APV-2A automatic system.

As to its principle design, the instrument is actually a voltmeter of B-1 type, calibrated in accordance with the variable ratio boost control unit rod setting position for different flying speeds and altitudes.

The APV arm position indicator has two scales to indicate speed and altitude, numbered within automatic system adjustment range for speed from 5000 m. to 10,000 m. and for altitude from 500 km/hr to 900 km/hr.

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The indicator pointer will show the I.A.S. and altitude within the above adjustment limiting range, the position of slave rod of the variable ratio boost control unit being in accordance with the I.A.S. and altitude at a given flight moment. Then:

At altitudes below 5000 m. the indicator pointer setting position by speed scale (outer scale) should roughly correspond to flight I.A.S.;

At altitudes ranging from 5000 m. to 10,000 m. the pointer position setting by the altitude scale (inner scale) should not be below the flight altitude at any speed (i.e. the right-hand "stop" for the pointer is the flight altitude).

Under flight conditions behind the adjustment range limits the indicator pointer should be at one of the extreme position settings: at I.A.S. over 900 km/hr (at altitudes below 5000 m.) the pointer should be at the right-hand stop; at I.A.S. below 480 km/hr (at all altitudes) and likewise at altitudes over 10,000 m. (at any speed) the pointer should be at the left-hand stop.

Note: Bear in mind that the automatic system is calibrated under standard atmospheric conditions. Under other conditions, the indicator readings, as taken off the altitude scale, will differ from the aircraft altimeter readings; the value of difference will increase proportionally and reach 1000 m. value above the altitude of 10,000 m.

The numbering diagram and example for using the arm position indicator of the variable ratio boost control unit is presented in Fig.40.

Within I.A.S. "A" variation range (i.e. up to the beginning of adjustment range of V_{inst}) the position indicator of the variable ratio boost control unit is at the initial mark of scale 5 - 10 corresponding to the bigger arm of APV-2A unit.

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Within adjustment range according to pressure head, the APV-2A position indicator readings will coincide with speed indicator readings by wide pointer of the combined speed indicator KVC.

Within adjustment range of the APV variable ratio boost control unit by altitude H, the APV position indicator readings coincide with BA-20 altimeter readings.

Note: The readings of the above instruments coincide with the APV indicator readings, with voltage in the aircraft mains equal to 28 ± 0.5 V, i.e. when generators are operating; when storage batteries are employed an error appears, i.e. the APV indicator readings will not correspond to the readings of the I.A.S. and flight altitude indicators which, however, may be neglected in the course of flight operation.

10. Accelerometer AM-10

Purpose

Small size accelerometer AM-10 is intended for determining load factors affecting the aircraft in direction perpendicular to the wing plane. The overload factors are in proportion to accelerations.

The acceleration measurement unit is gravity acceleration equal to $1 \text{ g}/9.81 \text{ m/sec}^2$.

The AM-10 accelerometer measurement range is within $\pm 5 \text{ g}$ to $\pm 10 \text{ g}$.

The AM-10 accelerometer serves to determine overloads when flying in bumpy air or executing advanced aerobatic manoeuvres.

Principle of Operation

The operation of the AM-10 accelerometer is based on the effect of inertia forces upon the mass placed on the arm

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so that the mass easily turns about the instrument axis in the instrument scale plane within a certain turning angle. This displacement is counteracted by operating spring torque.

Basic Specifications

Operation range from -5 g to $+10 \text{ g}$.
Instrument error should not exceed $\pm 0.3 \text{ g}$.

III. Engine Instruments

Those are:

- (1) Electrical remote-indicating tachometer 2T915-1.
- (2) Fuel quantity gauge and flowmeter TP3-52.
- (3) Exhaust gas thermoelectric dual thermometer 2TMT-411.

- (4) Board T-6.

- (5) Pressure warning mechanisms CA-3.

- (6) Pressure warning mechanism 2CIV-5 (in engine set).

Besides, a special box contains instruments: 3MM-3P, 3M-10, 3M-100, T3-15 and TBT-11 to check engine operation on the ground.

1. Electrical Remote-Indicating Tachometer 2T915-1

Electrical tachometer, type 2T915-1, is designed to continuously indicate the speed (in r.p.m.) of the shafts of two engines FA-95.

The tachometer is a set of two three-phase generators the frequency of which is proportional to the r.p.m. of the engines and two-pointer indicator for two engines. The indicator incorporates two measuring units fitted in one common case.

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The r.p.m. of the two engines are read off from a common scale of the indicator by means of two pointers.

The two pointers of the indicator are operated by two generators.

The set of tachometer 2T915-1 includes;

- (1) Generator AT-3 (2 pcs).
- (2) Indicator 2T915-1 (1 pc).

Specifications

Measurement range from 0 to 15,000 r.p.m.

Tachometer face is divided to each 200 r.p.m.

Errors within temperature range of $+20^{\circ}$ to -60°C

(See Table No.1).

Table No.1

Measurement range in r.p.m.	Errors in r.p.m.		
	$+20^{\circ} \pm 5^{\circ}\text{C}$	$+50^{\circ} \pm 5^{\circ}\text{C}$	$-60^{\circ} \pm 5^{\circ}\text{C}$
1000 - 9000	± 150	± 240	± 310
9000 - 12,000	± 75	± 120	± 195

Measurement of r.p.m. by tachometer 2T915-1 is based on conversion by the generator of the engine shaft rotary speed into e.m.f. with a frequency proportional to the shaft rotary speed, i.e. r.p.m. of the shaft.

The tachometer generator is driven from the engine. The three-phase electric current generated in the generator starter is supplied to the synchronous electromotor of the indicator.

The current passing through the stator winding of the indicator's synchronous electromotor sets up a rotary magnetic field which actuates the rotor consisting of permanent

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magnets and a hysteresis disc. The permanent magnets serve to ensure the starting and stabilized torques at low speeds.

The hysteresis disc is designed to ensure the starting torque at high speeds.

Generator AT-3 is an A.C. three-phase machine with a two-pole permanent magnet used as rotor.

Wires leading from the indicator are connected to the three-phase of the generator by aid of a plug socket and terminal block.

The indicator consists of two similar units fitted in one case. Each unit comprises a synchronous electromotor and sensitive element.

The pointers are marked II (right) and I (left).

The synchronous electromotor consists of a stator (three-phase winding placed in laminated core) and a rotor (two cross-shaped magnets).

Temperature compensation in tachometer 2T915-1 is effected in the following way. A shunt manufactured of special alloy is put on magnets in one half of the magnet assembly. The shunt permeability decreases with a temperature increase and, conversely, increases with a temperature decrease.

If a necessity arises to replace the 2T915-1 in the course of employment, it is necessary, before installation of the new instrument, to check the insulation resistance of the indicator and generator with a megger and also to check instrument errors at a normal temperature.

Before coupling the generator to the engine shaft, turn over, by hand, the generator shaft in the direction of the engine rotation and see that the wires are correctly connected to the plug sockets.

In this case the indicator pointer should turn clockwise.

If it turns incorrectly (counter-clockwise), check to see that the wires are correctly connected to the plug sockets.

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2. Fuel Quantity Gauge and Flowmeter TP3-52

The fuel quantity gauge and flowmeter is designed for measuring fuel contained in aircraft tanks and for warning the pilot about the dangerous level of fuel in the tanks.

Fuel quantity gauge and flowmeter TP3-52 is a combined instrument and comprises two independent meters: fuel quantity gauge T3C-47 of float-and-arm type and summation flowmeter PTC-16.

Gauge TP3-52 includes the following units:

- (a) Indicator, type TP3-52 (mounted on the instrument panel).
- (b) Transmitter of flowmeter PTC-16 (mounted in the fuel supply manifold of the engines).
- (c) Rheostat transmitter T3C-1417 (installed in the first fuel tank).
- (d) Thyatron interrupter NT-51M (mounted in the left-hand hatch between frames 11 and 12 beginning from series 8-51-NT-51M it is mounted on the port side between frames 14 and 15).
- (e) Spare thyatron TT-2050 (spare part).

The fuel quantity gauge and flowmeter operates as two independent units:

- (a) Fuel quantity gauge, type T3C-1417.
- (b) Flowmeter, type PTC-16.

The operation of the fuel quantity gauge is based on conversion of a non-electrical value, i.e. a varying fuel level, into an electrical value, i.e. variable ohmic resistance indicated by an electric measuring instrument. This conversion is accomplished by a rheostat transmitter fitted with a float-and-arm arrangement and located inside fuel tank No.1. As indicator, a moving-coil logometer is used.

As the fuel level varies, the float swimming on the fuel surface rises or falls within the tank and actuates the rheostat slide that moves inside the transmitter.

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The slide divides the total resistance of the rheostat into two resistance arms R_1 and R_2 . As the slide moves, the value of one resistance arm increases while that of the other decreases with the result that a change in the R_1 and R_2 resistance values brings about a change in the values of currents I_1 and I_2 that flow through the logometer coils.

The fuel flowmeter operates on the following principle. Fuel flowing through the meter at a certain rate causes rotation of the helical vane wheel of the transmitter, its r.p.m. being proportional to the flow rate and, hence, to the quantity of fuel consumed by the engines.

The rotating vane wheel through a reducing gear and magnetic coupling actuates a pulser. Every 30 revolutions of the vane the pulser sends one voltage pulse to the grid of thyatron TT-2050.

The indicator relay is connected into the plate circuit of thyatron TT-2050 which is energized with 48 V, 400 c.p.s. current from the winding of power transformer TP.

If a negative potential of 5 V is delivered to the thyatron grid, the 48 V plate voltage is not sufficient for firing the thyatron.

As a result, the thyatron is cut off, the plate current discontinues and the indicator relay gets de-energized.

The thyatron grid potential is controlled by the pulser contacts, hence, at the time the contacts are open, a zero potential is applied to the thyatron grid, which fires the thyatron and causes the indicator relay to operate. This period corresponds to a pulse.

When the pulser contacts are closed, a negative potential is delivered to the thyatron grid which extinguishes the thyatron and de-energizes the relay winding. This period corresponds to a pause.

Every 30 revolutions of the vane the pulser commutator makes one complete turn and sends out one pulse into the

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indicator relay. Thus, the number of relay operations is proportional to the r.p.m. of the transmitter vane, hence, to the amount of fuel consumed.

The indicator relay, through the gears, actuates the indicator pointer which reads the amount of residual fuel for a given period of time.

Specifications of Fuel Quantity Gauge

The fuel quantity gauge is supplied from a 27 V D.C. source.

The calibration errors of the fuel quantity gauge at a normal temperature (20°C) and at a voltage of 27 V do not exceed values tabulated below:

Dial portions	Calibration error in per cent of rated values of dial
Zero setting	±2.5
Other dial portions	±5.0

The fuel quantity gauge readings are true only for level straight flight.

Additional errors of the fuel quantity gauge for voltage variation within ±10 per cent of 27 V do not exceed ±1 per cent.

Current drawn by the fuel quantity gauge does not exceed 150 mA. As a result of manoeuvres and bumps of the aircraft which cause the fuel level to vary, the pointers may oscillate and the lamp of the warning unit may start to flicker.

The errors of the indicator on the fuel quantity gauge dial should not exceed ±1 per cent against zero and the first division, and ±2 per cent against other divisions.

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The additional error of the indicator due to changes of ambient temperature does not exceed ±0.5 per cent for each 10° variation of the rated temperature (+20°C).

The fuel quantity gauge transmitter is designed to operate under conditions of vibration with an acceleration of 4 g.

The calibration error of the transmitter with a standard logometer is ±1 per cent at zero, ±3 per cent at other dial divisions.

The fuel quantity gauge transmitter operates reliably within an ambient temperature range of +50°C to -60°C.

The warning unit starts to operate when the fuel level drops to 550 litres.

Specifications of Fuel Flowmeter

Summation flowmeter PTC-16 measures fuel consumption within 400 to 8000 litres per hour.

The error of the flowmeter at an ambient temperature ranging from +50 to -60°C and with an equivalent viscosity of 15 c.s. for the mixture of fuel and oil does not exceed ±4.5 per cent of the rated value of the indicator dial.

The pressure drop in the transmitter at a normal temperature of +20°C and at a fuel consumption of 8000 litres per hour does not exceed 0.25 kg/sq.cm. with the vane wheel operating and 0.40 kg/sq.cm. with the vane wheel stalled.

The inner chamber of the transmitter case as well as the joint of the branch pipe to the transmitter case are hermetically sealed and tested to a liquid pressure of 5 kg/sq.cm.

Power consumption of the flowmeter is 30 W at 400 c.p.s.

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3. Exhaust Gas Temperature Twin Gauge 2TBF-411

The exhaust gas temperature twin gauge, type 2TBF-411, is designed for remote measurement of engine exhaust gas temperature in the range of 300° to 900°C.

Gauge 2TBF-411 incorporates:

- (a) Indicator 2TBF-4 (1 pc) mounted on the instrument panel.
- (b) Thermocouples T-1 (8 pcs) mounted on engine (4 pcs per each engine).
- (c) Connection blocks with wiring (2 pcs) mounted in the fuselage tail section on frame 24.

Specifications of Temperature Twin Gauge

The temperature gauge errors should not exceed the values tabulated below:

Ambient temperature	Error of temperature indicator in degrees in range of		
	450-650°C	650-750°C	Remaining part of dial
+20° ±5°C	±12	±8	±20
+50° ±5°C	±15	±15	±27
-60° ±5°C	±17	±17	±32

The gauge withstands vibration load of 1.5 g, (its transmitter 4g). Pointer oscillations should not exceed ±1 mm over the dial arc, the one-side displacement (declination) should not exceed 1 mm.

Transmitter resistance is 2.5 ±0.1 ohms.

Indicators and thermocouples are interchangeable only within their calibration group.

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The calibration group is marked on the indicator face and thermocouple case.

Table of Calibration

Calibration group	Values of thermal e.m.f. in mV at temperatures						
	300°C	400°C	500°C	600°C	700°C	800°C	900°C
1	1.68	6.68	13.92	21.72	29.84	37.92	45.96
2	1.52	6.40	13.64	21.44	29.56	37.64	45.68
3	1.36	6.12	13.36	21.16	29.28	37.36	45.40

4. Board of Lamp Register T-6

Application

Lamp register T-6 is designed to provide warning light about:

- Afterburning of the two engines.
- Pressure drop in the oil system of the two engines.
- Fuel being all used up in the first tank.
- Fuel level corresponding to 550 litres.

Operating Principle

Lamp register T-6 operates from transmitters which are mounted complete with other units.

When coming into operation a transmitter closes the electric circuits with the result that a respective lamp comes on and illuminates the warning inscription.

The lamp register is connected to the transmitters through relay PH-6 which makes it possible to check the condition of the lamps with the transmitters being simultaneously disconnected from the lamp register.

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Lamp register T-6 is designed so that the lamp of the inscription 550 LITRES LEFT (ОСТАЛОСЬ 550 ЛИТРОВ) uses a double-wire system and the other lamps use a single-wire system.

Two warning inscriptions AFTERBURNING (ФОРСАЖ) are painted green, the other inscriptions are of red colour.

Lamp register T-6 is provided with a device to check the condition of the lamps and with a special blind to reduce the brightness of warning inscriptions in night conditions.

The operating voltage applied to the lamp register is 27 V $\pm 10\%$, D.C.

5. Fuel Pressure Warning Mechanism ЦД-3

Fuel pressure warning mechanism ЦД-3 serves to warn about excessive pressure drop in fuel pipe lines.

The operating principle of the pressure warning mechanism is based on the functional relation between pressure and elastic deformation of a sensitive element.

The aircraft is equipped with four pressure warning mechanisms:

(1) Mechanism ЦД-3 to check operation of the pump of tank No.1 (mounted in the engine section, top, on frame 15). At the same time it serves to block the cut-in of ratings MAXIMUM (МАКСИМУМ) and AFTERBURNING (ФОРСАЖ) according to the pressure of main fuel.

(2) Mechanism ЦД-3 to check operation of the pump of tank No.2. It is mounted on the port side, bottom, between frames 13 and 14.

(3) Mechanism ЦД-3 to check operation of the pump of fuel tanks Nos 3 and 4 (mounted on frame 22, bottom).

(4) Mechanism ЦД-3 to indicate that fuel in drop tanks is all used up (mounted on frame 15, top along the aircraft axis of symmetry).

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Specifications of ЦД-3.

The warning mechanism switches on the warning lamp at a drop of excessive pressure in a fuel pipe line below 0.3 kg/sq.cm.

The instrument operates reliably within the temperature range of $+80^{\circ}$ to -60°C .

The instrument is rated to cut in and out a 50 W warning lamp at 27 V ± 10 per cent.

The error in operation of the warning mechanism does not exceed ± 0.05 kg/sq.cm. at a temperature of $+50^{\circ}$ to -60°C .

Airtightness of the instrument in the receiving part: pressure should not drop for 10 min. at air pressure of 3 kg/sq.cm. as checked against a pressure gauge.

Airtightness of the instrument in the case: when pressure equal to 300 mm of mercury head is simultaneously supplied to the static and dynamic systems, the pressure drop for 1 minute should not exceed 8 mm of mercury head.

The instrument withstands a dynamic pressure overload of 5 kg/sq.cm. for 5 min. Insulation resistance of the instrument at a normal temperature and a relative humidity within 30 to 80 per cent is not less than 20 megohms.

IV. Aircraft Individual Units Control Instruments

The instruments of the above type are:

1. Cabin altitude and pressure indicator.
2. Air and hydraulic pressure gauges.
3. Flight and landing control instruments board.

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I. Cabin Altitude and Pressure Indicator, Type YBMT-15 - - -

The type YBMT-15 indicator is intended to measure "altitude" in the airtight cockpit and difference (drop) between the pressure in the cockpit and that of the free air.

The type YBMT-15 indicator is a combined instrument incorporating an altimeter and a differential pressure gauge arranged in one housing and functioning independently.

The altimeter measures pressure in the cockpit at various altitudes by use of a system of aneroid chambers.

The differential pressure gauge measures the difference of pressures in the aircraft airtight cockpit and the surrounding atmosphere by means of a pressure gauge cell.

Actuated by pressure difference (in and outside the cell) the diaphragm chambers and as a result the cell upper centre attains the linear displacement converted to the rotary motion of the instrument pointer through the linkage.

2. Air and Hydraulic Pressure Gauges

Mounted on the right-hand side of the instrument panel fixed portion is pressure gauge M-1000 indicating the surplus pressure in the oxygen apparatus.

Mounted below on the instrument panel fixed portion are pressure gauge MT-250M used to check the hydraulic booster operation and two-pointer 12-kg/cm² pressure gauge MB-12M for checking the brake system operation.

Installed on the starboard console horizontal portion are:

- (a) 80-kg/cm² pressure gauge MB-80M - for checking pressure in the emergency flap extension system.
- (b) 250-kg/cm² pressure gauge MT-250M - for checking pressure in the main hydraulic system.

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- (c) 250-kg/cm² pressure gauge MB-250 - for checking pressure in the emergency landing gear extension system.
- (d) 250-kg/cm² pressure gauge MB-250M - for checking pressure in the main air bottle system.

Main Specifications

1. Main error should not exceed:
in pressure gauges MB-250M and MT-250M ± 10 kg/cm²
in pressure gauges MT-150M ± 4.8 kg/cm²
in pressure gauges MB-80M ± 3.2 kg/cm²
in pressure gauges MB-12M ± 0.48 kg/cm².
2. Reading variation should not exceed the main error value.
3. The pointer jerky movement should not exceed 1 per cent of the upper measuring limit.

3. Flight and Landing Control Instrument Board MTC-2 -

This is intended for furnishing the operator with light signals as to the position of the landing gear, landing flaps, and air brakes, as well as for giving him warning of necessity to extend the landing gear when preparing for landing (a red warning lamp marked EXTEND L.G. - ВЪПУСТИ ШАССИ).

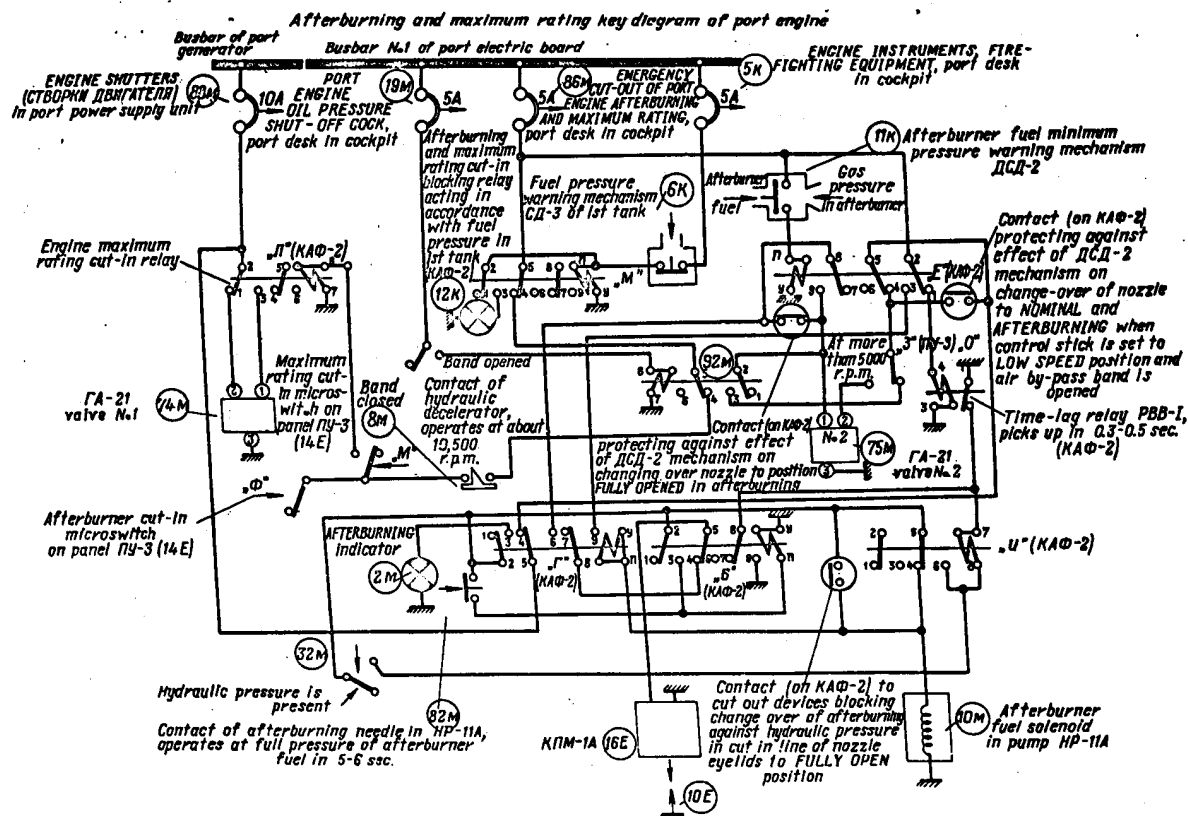


Fig. 1. Afterburning and Maximum Rating Key Diagram



1 - button ПК; 2 - APY-2A position indicator; 3 - pilot lamp of APY-2A take-off and landing position; 4 - manual control switch of APY-2A; 5 - computing unit of APY-2A; 6 - air speed tube; 7 - inertia load; 8 - mismatch transmitter ДР-5; 9 - spring-feel mechanism; 10 - МП-100М electric actuator; 11 - АСП-4 electric actuator; 12 - booster БЭ-14МС; 13 - variable ratio boost control unit APY-2A; 14 - АСП-4 cut-in cylinder switches; 15 - valve ГА-74М/5; 16 - valve KB3M to cut in electric actuator.

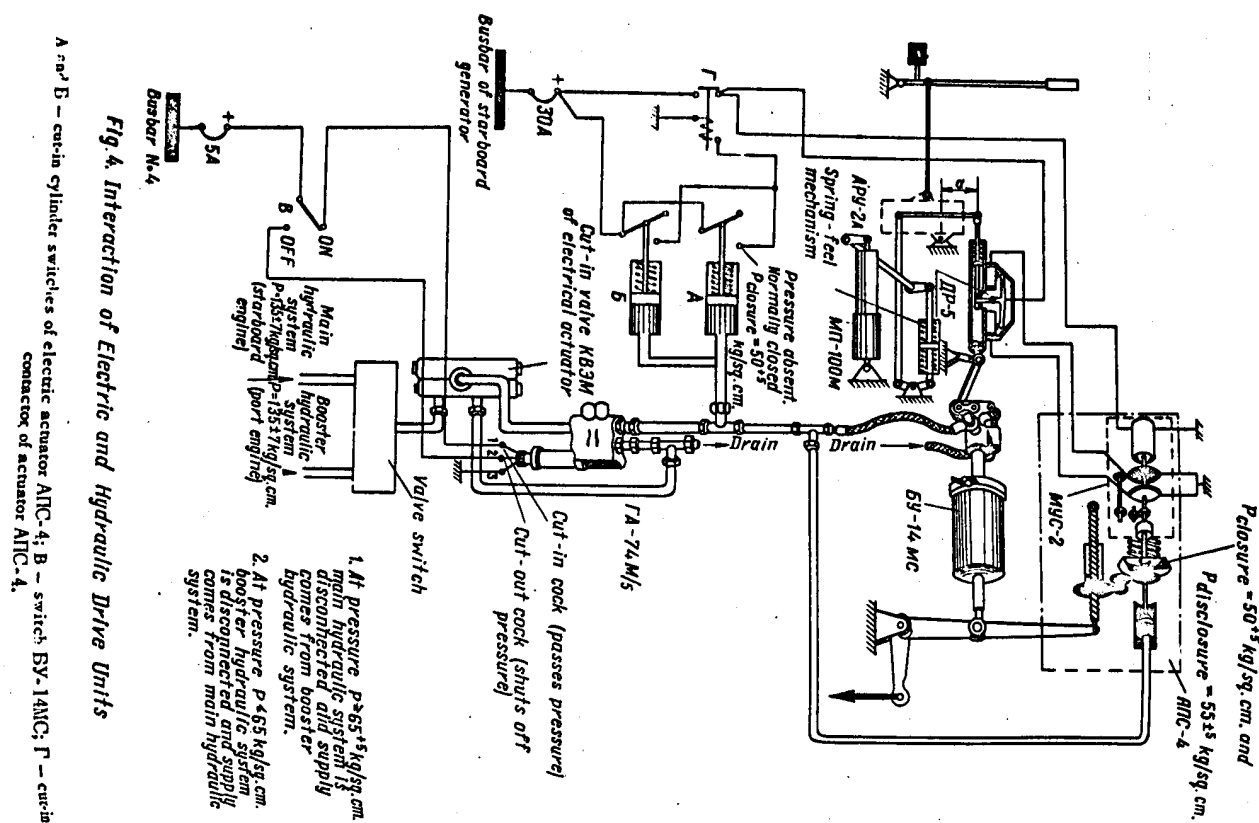


Fig. 4. Interaction of Electric and Hydraulic Drive Units

A and B - certain cylinder switches of electric actuator APC-4; B - switch, BY-14NC; T - cut-in contact of actuator APC-4.

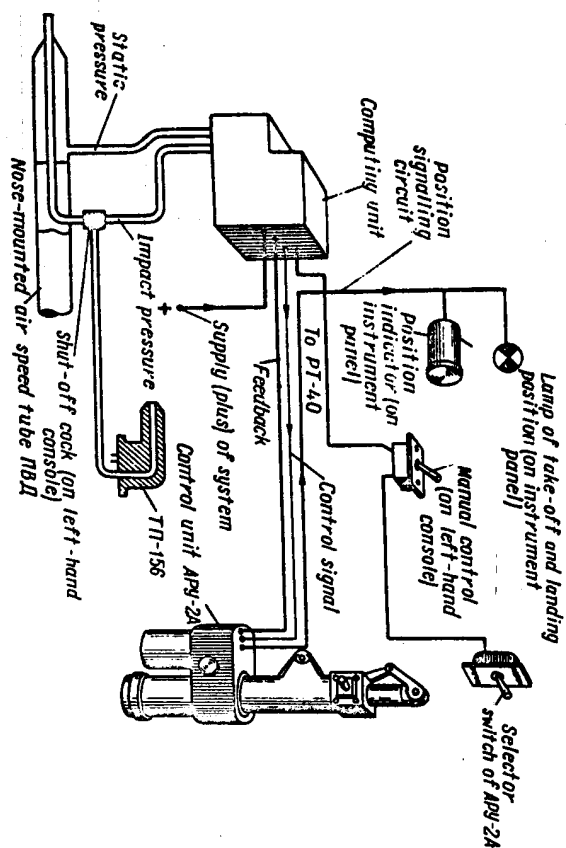


Fig. 5. Pictorial Diagram of Automatic System

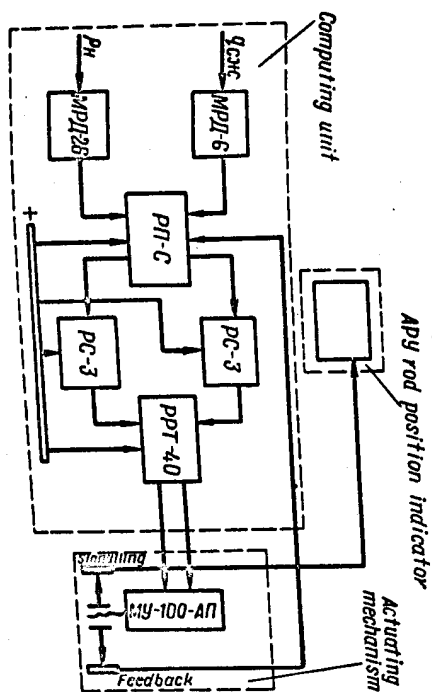


Fig. 6. Block Diagram of Automatic System

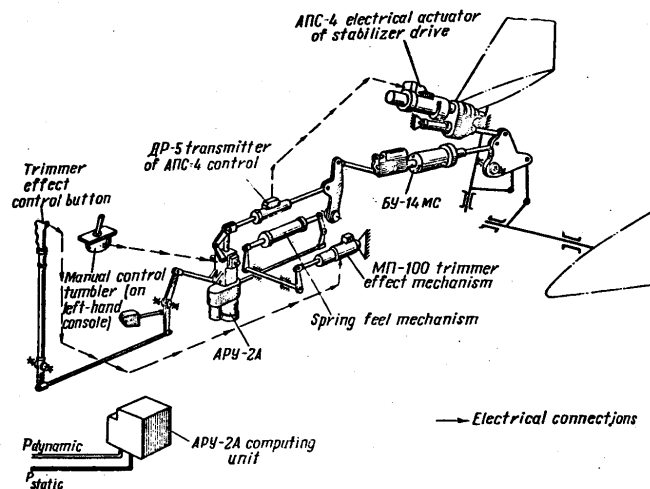


Fig. 7. Pictorial Diagram of Stabilizer Control

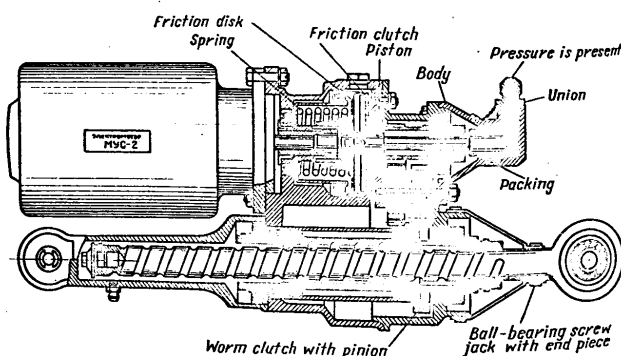


Fig. 8. Electrical Actuator ANC-4

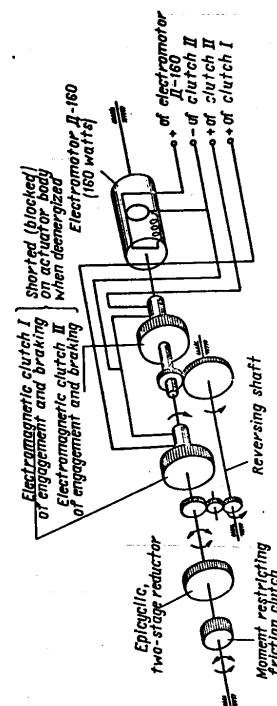


Fig. 9. Key Diagram of MVC-2

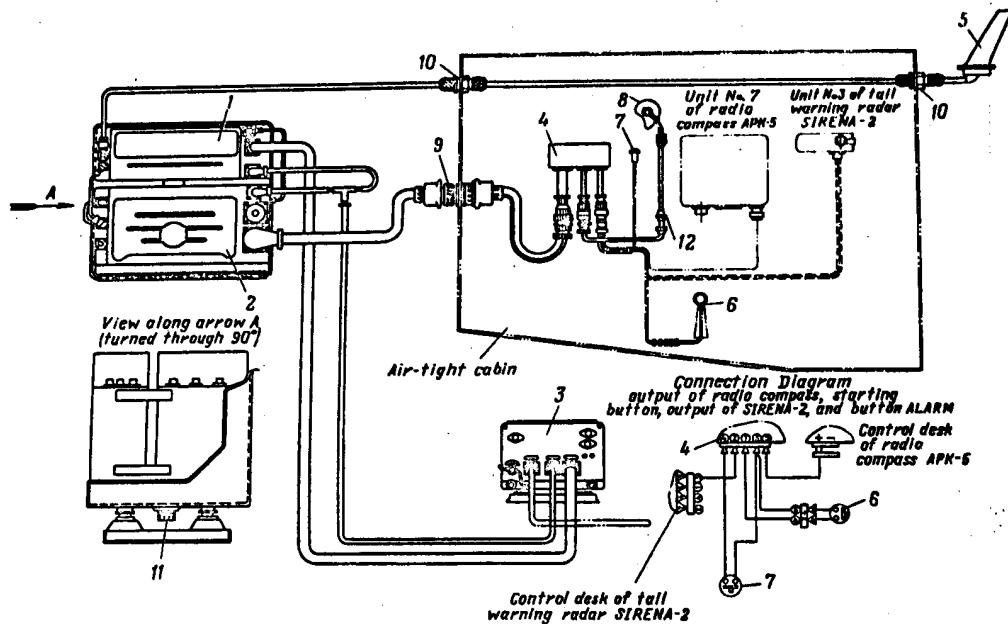


Fig. 10. Connection Diagram of Radio Station PCMY-4

1 - Transmitter (unit A); 2 - Receiver (unit B); 3 - Rectifier (unit B-1); 4 - Control desk (unit B-1); 5 - Rod antenna; 6 - Transmission button on throttle control lever; 7 - ALARM button; 8 - Head gear; 9 - Sealed connector; 10 - R.F. sealed connector; 11 - Anti-radar filter; 13 - Common connector.

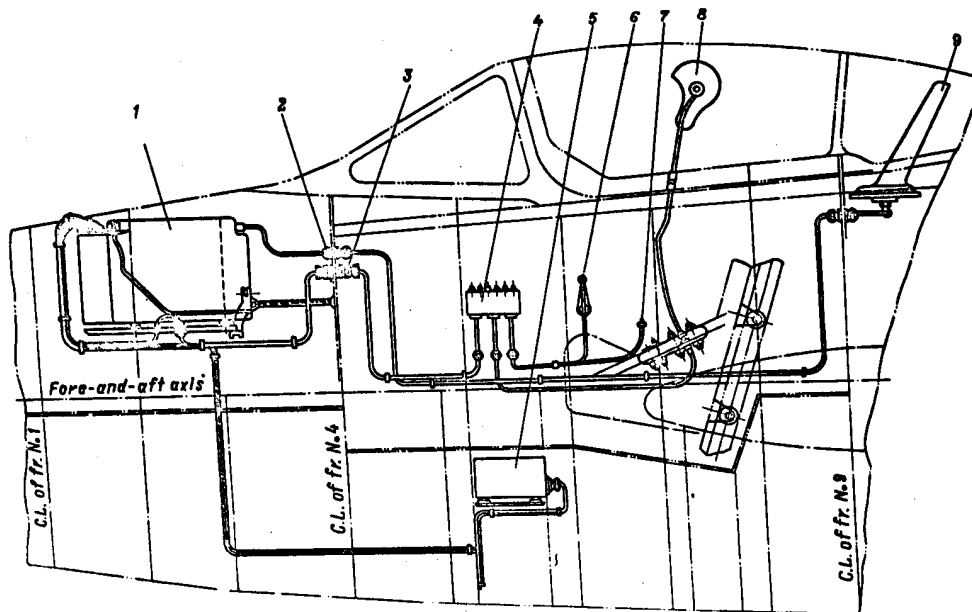
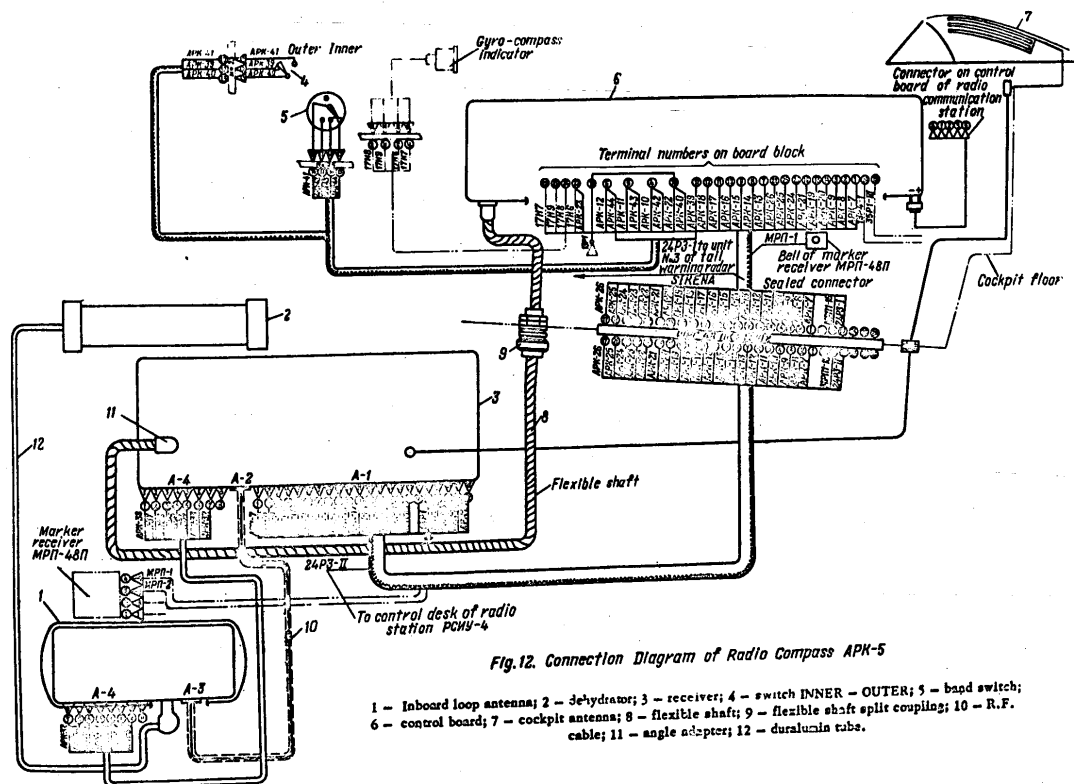


Fig. 11. Lay-Out of PCMY-4 Units on Aircraft

1 - Transmitter (unit A) and receiver (unit B); 2 - R.F. sealed connector; 3 - sealed connector; 4 - control desk (unit B-1); 5 - rectifier (unit B-1); 6 - transmission button on throttle control lever; 7 - ALARM button; 8 - head gear; 9 - antenna.



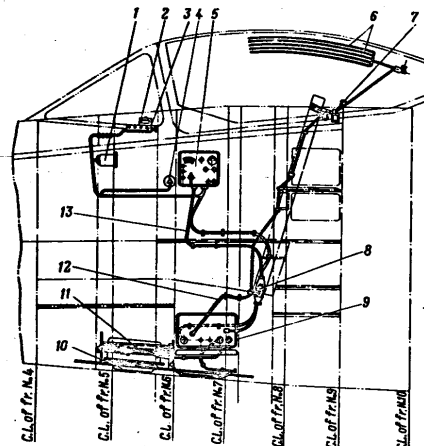


Fig. 13. Lay-Out of Radio Compass ARK-5 Units

1 - Course indicator (from gyro-compass ГИК-1); 2 - plotting board;
3 - switch INNER - OUTER; 4 - band switch; 5 - control board; 6 - canopy
antenna; 7 - detachable contact of canopy antenna; 8 - 26-terminal sealed
connector; 9 - receiver; 10 - loop antenna; 11 - dehydrator; 12 - canopy
antenna download; 13 - flexible shaft.

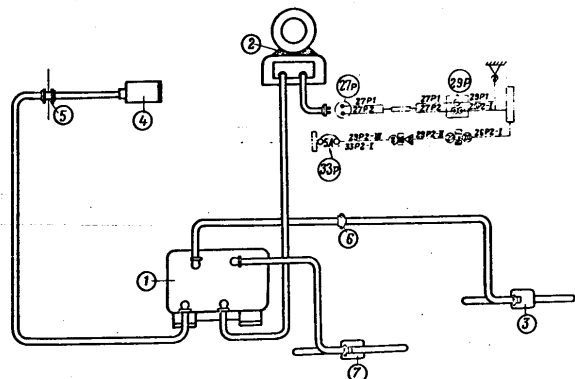


Fig. 14. Connection Diagram of Radio Altimeter PB-2

1 - Transceiver; 2 - converter PY-11A1; 3 - receiving antenna; 4 - indicator; 5 - sealed
connector; 6 - R.F. one-terminal connector; 7 - transmitting antenna.

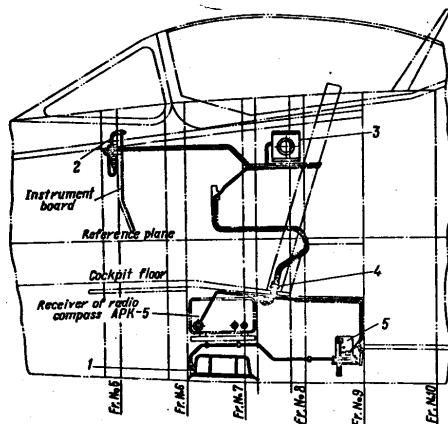
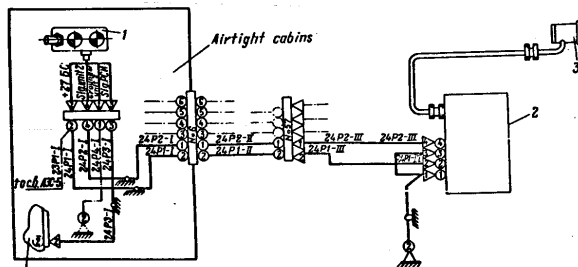


Fig. 18. Lay-Out of Marker Receiver MPPI-48Π Units

1 - Inboard loop antenna; 2 - pilot lamp; 3 - electric bell; 4 - 26-terminal sealed connector of radio compass APK-5; 5 - receiver MPPI-48Π.



Control desk of radio communication station PCMY-4

Fig. 19. Connection Diagram of Tail Warning Station SIRENA-2

1 - Control desk (unit No. 3); 2 - receiver-amplifier (Unit No. 2); 3 - antenna and detector head (unit No. 1).

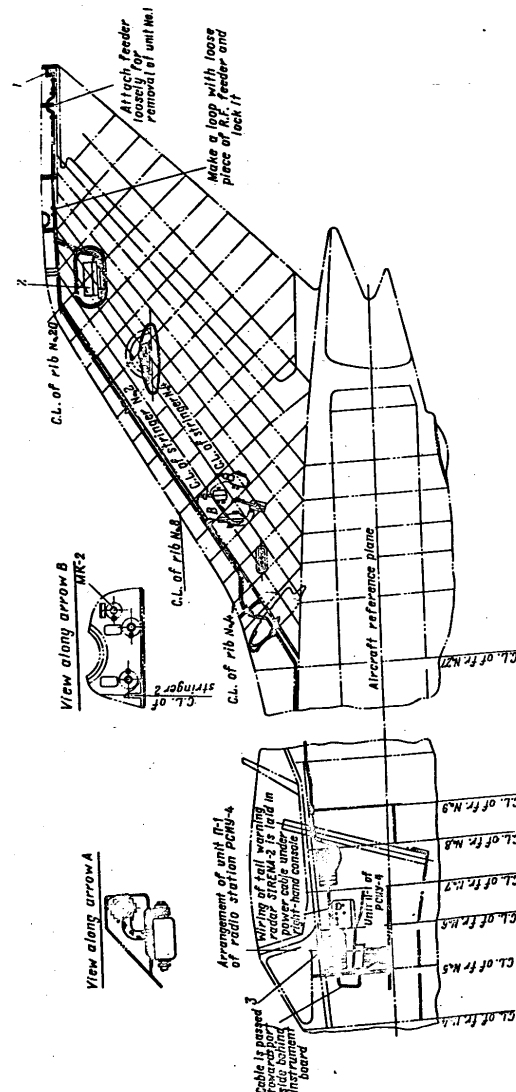


Fig. 20. Lay-Out of Tail Warning Radar Units

1 - Antenna and detector head; 2 - receiving amplifier unit; 3 - control desk (unit No. 3).

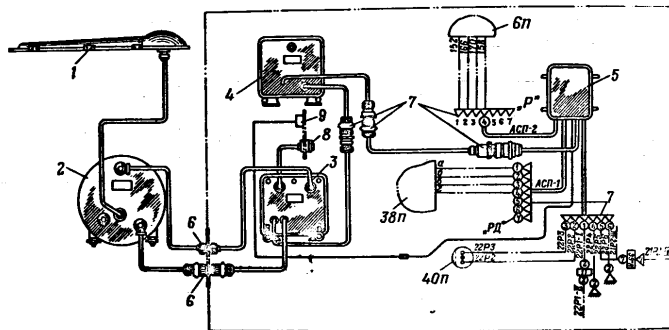


Fig. 21. Connection Diagram of Radio Range Finder CPD-1M

1 - Antenna (unit No. 1); 2 - Transceiver (unit No. 2); 3 - Range unit (unit No. 3); 4 - Supply unit (unit No. 4); 5 - Control desk (unit No. 6); 6 - R.F. sealed connector; 7 - Technological joints; 8 - Test connector; 9 - Range switch; 6n - distribution box of sight ACT-5H; 36n - control desk of sight ACT-5H; 40n - target resetting button.

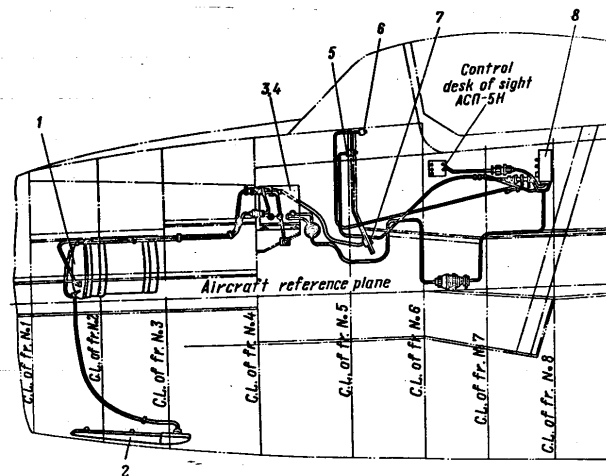


Fig. 22. Lay-Out of Radio Range Finder Units

1 - Transceiver (unit No. 2); 2 - antenna (unit No. 1); 3 - range unit (unit No. 3); 4 - supply unit (unit No. 4); 5 - range switch; 6 - target resetting button; 7 - test connector; 8 - control desk - unit No. 6.

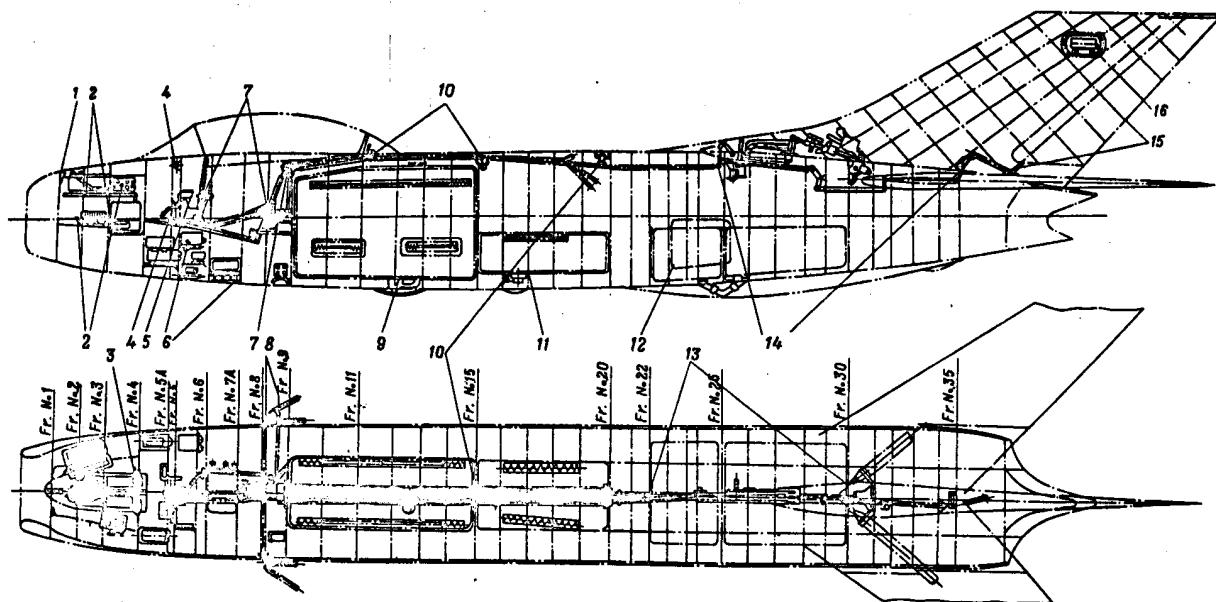


Fig. 23. Complete Diagram of Aircraft Bonding System
(Sheet 1)

1 - Bonding strips of hatch cover of upper equipment compartment; 2 - Bonding strips of units of radio station PCMV-4, radio range finder CPD-1M, radio altimeter PB-2, and aircraft transponder arranged in upper equipment compartment; 3 - Bonding strips of boards of L.G. nose strut; 4 - Bonding strips of instrument board; 5 - Bonding strips of control board of radio station PCMV-4; 6 - Bonding strips of units of radio compass APK-3, marker receiver MPPI-48M and electric equipment units arranged in lower equipment compartment; 7 - Bonding strips of rods and bell cranks for controlling aircraft and its engines (in cockpit); 8 - Bonding strips of aileron control rods and bell cranks at joint of wing and fuselage; 9 - Bonding strips of negative overload chamber in fuel tank No. 1; 10 - Bonding strips of control rudder and stabilizer rods and bell cranks (behind cockpit); 11 - Bonding strips of pump of fuel tank No. 2; 12 - Bonding strips of air brakes; 13 - Bonding strips of fuel tanks Nos 3 and 4; 14 - Bonding strips of rudder and stabilizer control rods and bell cranks (behind frame 24); 15 - Bonding strips of rudder.

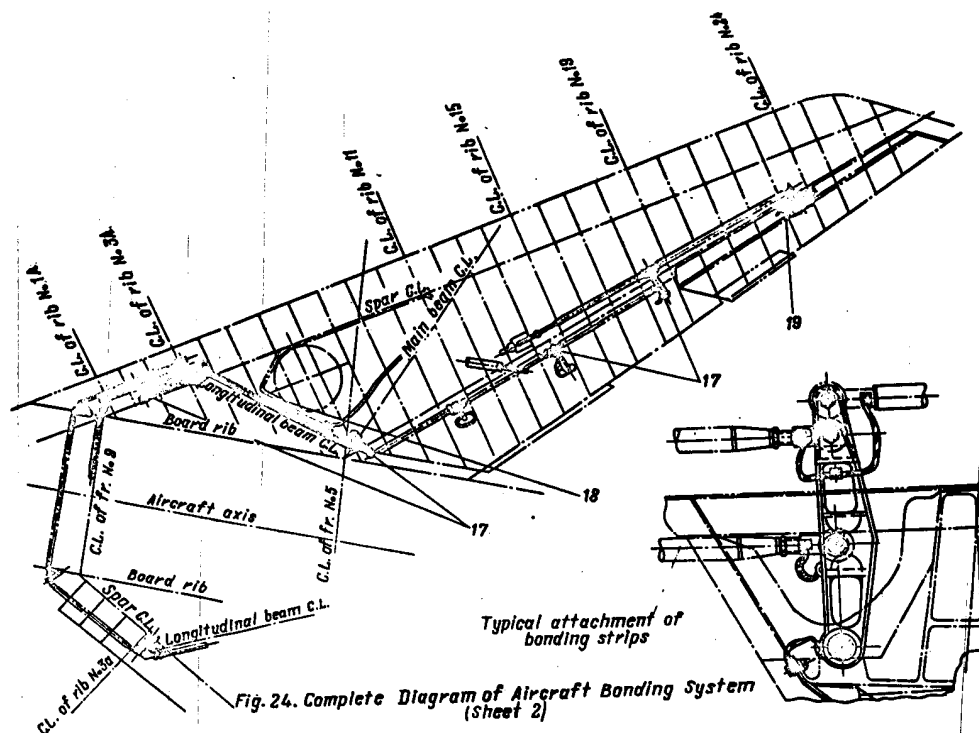


Fig. 24. Complete Diagram of Aircraft Bonding System
(Sheet 2)

17 - Bonding strips of ailerons and interceptors control rods and bell cranks (in wing); 18 - Bonding strips of main L.G. strut; 19 - Bonding strips of aileron.

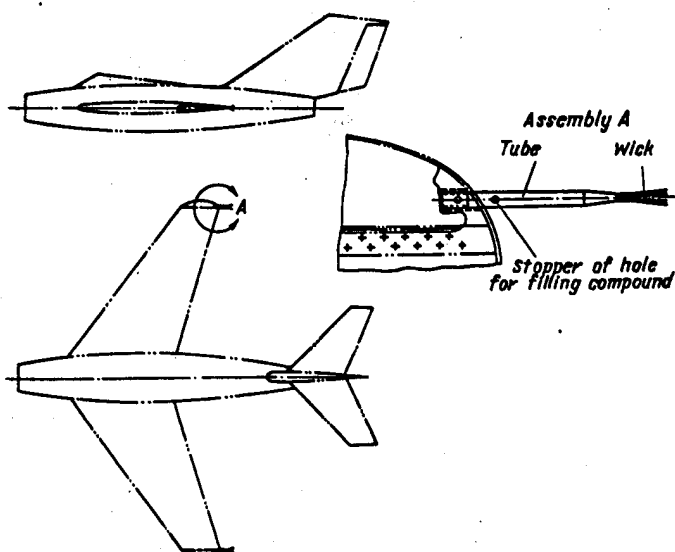


Fig. 25. Diagram Showing Installation of Static Dischargers

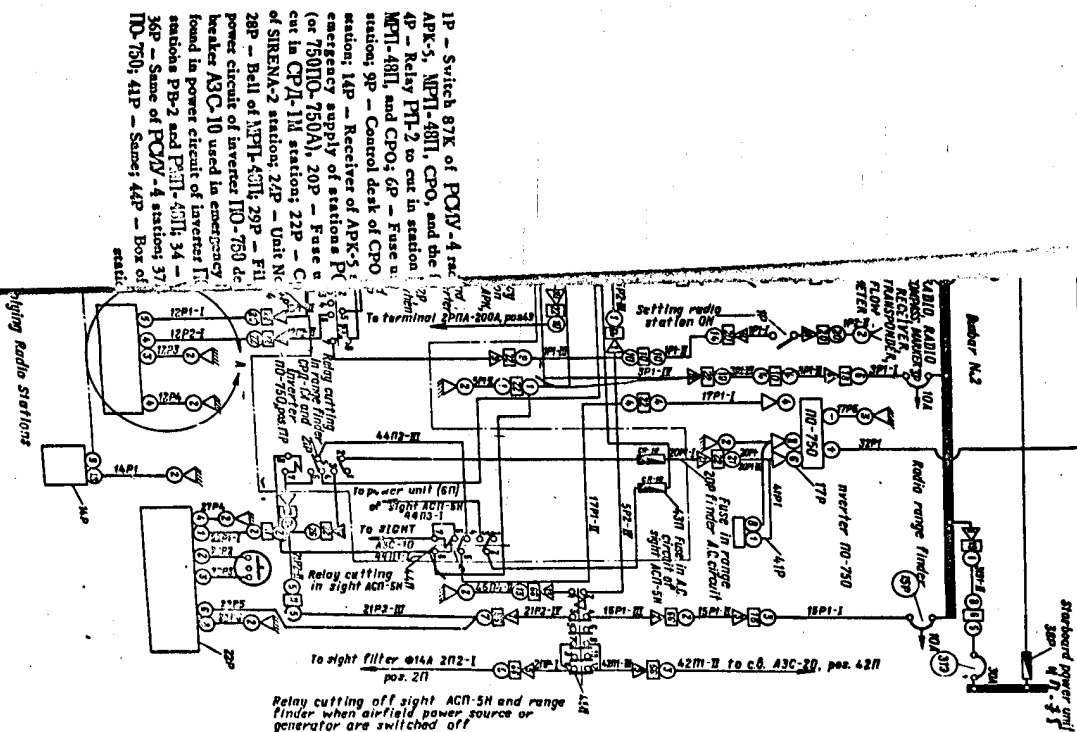
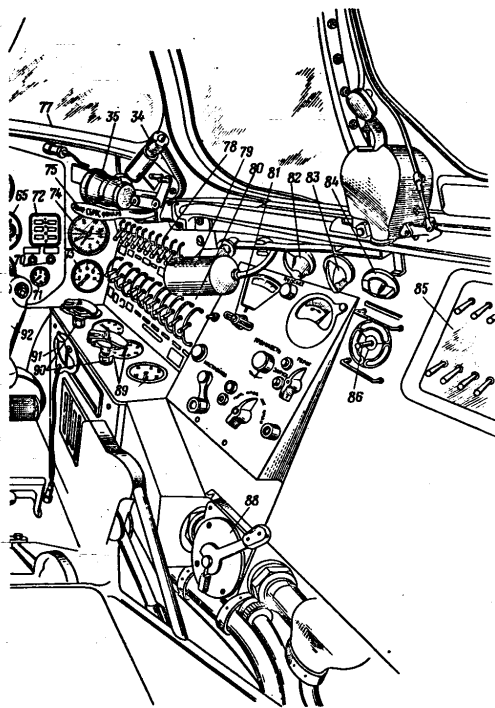


Fig. 26. Key Feeder Diagram of Supplying Radio Stations

1 - Oxygen valve ON (ОКРПЫЛ), OFF (ЗАКРПЫЛ); 2 - Automatic pressure unit; type АД-5; 3 - Speed-breaker to emergency pilot-tube (ПТ-156) selector switch; type АД-5; 4 - Navigation lights 30 - Engine start button; 6 - Flap control board; 7 - Parachute release button; 8 - APK-5 load change-over switch; 9 - DV-2 oxygen apparatus remote control; 10 - Type-lamp; 11 - KИ-30 oxygen apparatus; 11 - C-5 unit control board; 12 - Ultraviolet irradiation selector switch ПИ-45; 15 - Automatic-to-manual operation switch РХ of variable rate control unit; 17 - АСП-15 night control board; 18 - Alarm button; 19 - Engine control lever; 20 - Rockets emergency release button; 21 - Signal flare pistol switch; 22 - Circuit breakers of extinguisher shut-off cocks and airline breakers of fuel pump circuit; 24 - Buttons of fire radio station control board; 27 - Oxygen indicator; 28 - Landing gear control; 29 - Communications and landing control instruments board; 30 - Control board of SIRENA tail warning radar indicating lamp; 31 - Two indicating lamps of tanks; 32 - Deicer button; 33 - Ultraviolet irradiation lamp; 36 - APK-5 homing station switch; 37 - Canopy ejection cylinder; 35 - Ultraviolet AM-100; 38 - Overcharging board; 39 - Bomb or tank emergency jettisoning button 205K; 40 - 20K-100 control indicating; 41 - Indicator of emergency jettisoning unit 205K; 42 - 1200 m. - 2000 m. switch; 43 - Gyro-compass compass indicator; 44 - Radar set; 45 - Target receiving; 46 - APK-5 homing station switch; 47 - Gyro-compass; 48 - Unit performance

49 - Indicating lamp TRIM TAB EFFECT NEUTRAL; 50 - Arm lamp control button;
51 - PD-27 radio-altimeter indicator; 52 - BA-20 altimeter; 53 - AFX electric 5A - Indicating
lamp marked MARKER (CAUTION); 55 - 3VBT-5S electric arm indicator; 56 - Three B-M-C-S
counter; 57 - 2B-45 switch effect TACTICAL RELEASE (TAKING RECOVERY CIRCUS);
58 - Warning lamp marked ARMED (EXPLOSIVE); 59 - Two warning lamps marked SUSPENDED
(HOLDING BACK); 60 - MP-220 pressure gauge; 61 - Temperature 12 lb/cm² pressure gauge;
62 - Green warning lamp marked SUSPENSION TAKES (GOING DOWN); 63 - Indicator
M-I-5; 64 - BA-150 voltmeter; 65 - Exhaust gas thermometer; 66 - ACMA-1 electric bulb;
67 - Two CAK warning lamp marked RESTARTED IN THE DARKLIGHT OF (BLACK B
gauges and connectors; 68 - 2TA-15 tachometer; 69 - Indicator of TQ-5 fuel quantity
TOR OFF (FUEL PUMP STOPPED); 70 - Two GJ-51 warning lamps; PORT GENERATOR
ELECTRIC FUEL LINE; 71 - B-1 voltmeter; 72 - T-6 warning lamp; 73 - M-C-5 pressure
handle; 74 - YE-14 cabin altitude and pressure indicator; 75 - Canopy emergency release
electric bulb; 76 - Switches and circuit breakers; 79 - KZC-45 cockpit light; 80 - Right-hand
85 - Right hand electric bulb with circuit breakers permanently connected; 86 - 5A - 5A - 5A -
pit heating system;
A-RDP80T00246A062100060001-5



neral View)

34 - Lamp TRIM TAB EFFECT NEUTRAL; 50 - Arm lamp control button;
 radio-altimeter indicator; 52 - B/L-20 altimeter; 53 - ANX clock; 54 - Indicating
 MARKER (МАРКЕР); 55 - 3VIL-53 electric turn indicator; 56 - Three 3-M-C05
 test; 57 - 2B-45 switch marked TACTICAL RELEASE (ТАКТИЧЕСКИЙ СЕРОС);
 g lamp marked ARMED (ВЗРЛБ); 59 - Two warning lamps marked BOMBS SUSPENDED
 A BOMB); 60 - M-250 pressure gauge; 61 - Two-point 12 kg/cm² pressure gauge;
 warning lamp marked SUSPENSION TANKS (ПОДВЕШЕННЫЕ БАКИ); 63 - Machmeter
 BAP-150 variometer; 65 - Exhaust gas thermometer; 66 - ACT-5H sight head;
 TUK warning lamp marked RESTARTED IN THE AIR, IGNITION OFF (ЗАПУСК В
 ПРОЗВЕЛ, ЗАЖИГАНИЕ ВЫКЛЮЧЕНО); 68 - Indicator of TP3-52 fuel quantity
 lowmeter; 69 - ZTS-15 tachometer; 70 - Two CIII-51 warning lamps; PORT GENERA-
 LEVYI (ГЕНЕРАТОР ВЫКЛЮЧЕН); STARBOARD GENERATOR OFF (ПРАВЫЙ
 Р ВЫКЛЮЧЕН); 71 - B-1 voltmeter; 72 - T-6 warning board; 73 - M-1000 pressure
 VENT-15 cabin altitude and pressure indicator; 75 - Canopy emergency release
 - Switches and circuit breakers; 79 - K/COPK-45 cockpit lamp; 80 - Right-hand
 rd; 81 - APK-5 station board; 82 - PVQO-45 rheostat; 83 - Same; 84 - Same;
 rear electric board with circuit breakers permanently connected; 86 - ППН-20 cock-
 switch; 88 - Cockpit supply cock; 89 - Air and hydraulic system gauges; 90 - Flaps
 gears emergency control valve; 91 - Landing gear nose strut emergency unlock
 - Pilot's control stick; 93 - Parallelogram pedal mechanism; 94 - Pilot's seat;
 g lamp of pressure drop in the main and booster hydraulic systems; 96 - TUK-1 gyro-
 compass matching button.

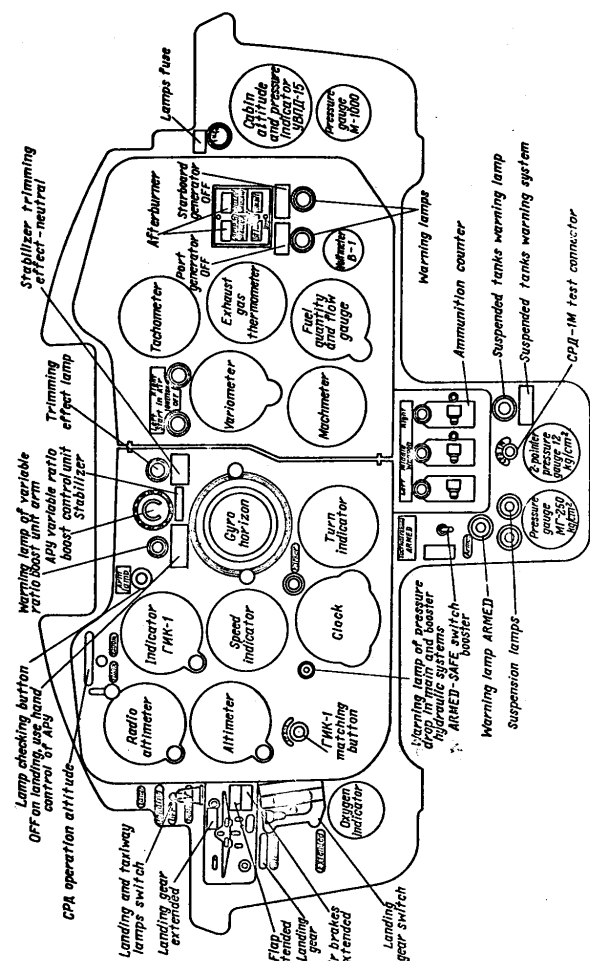
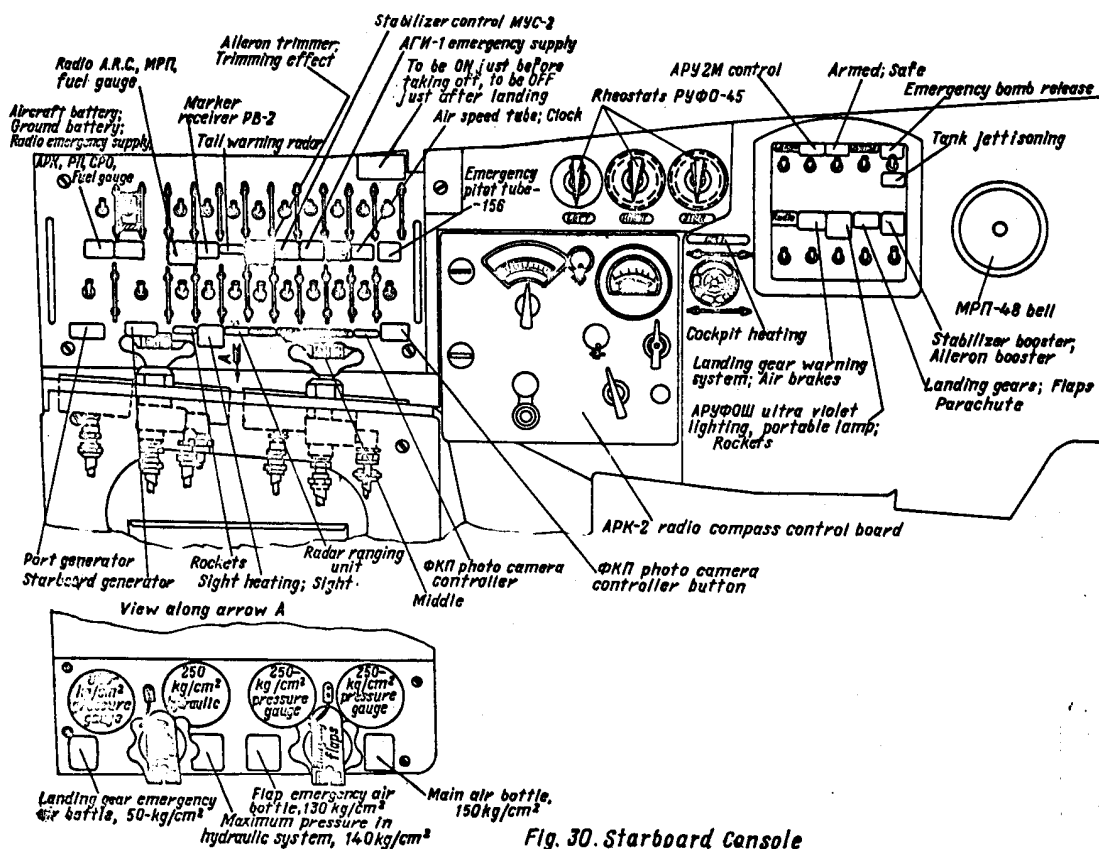
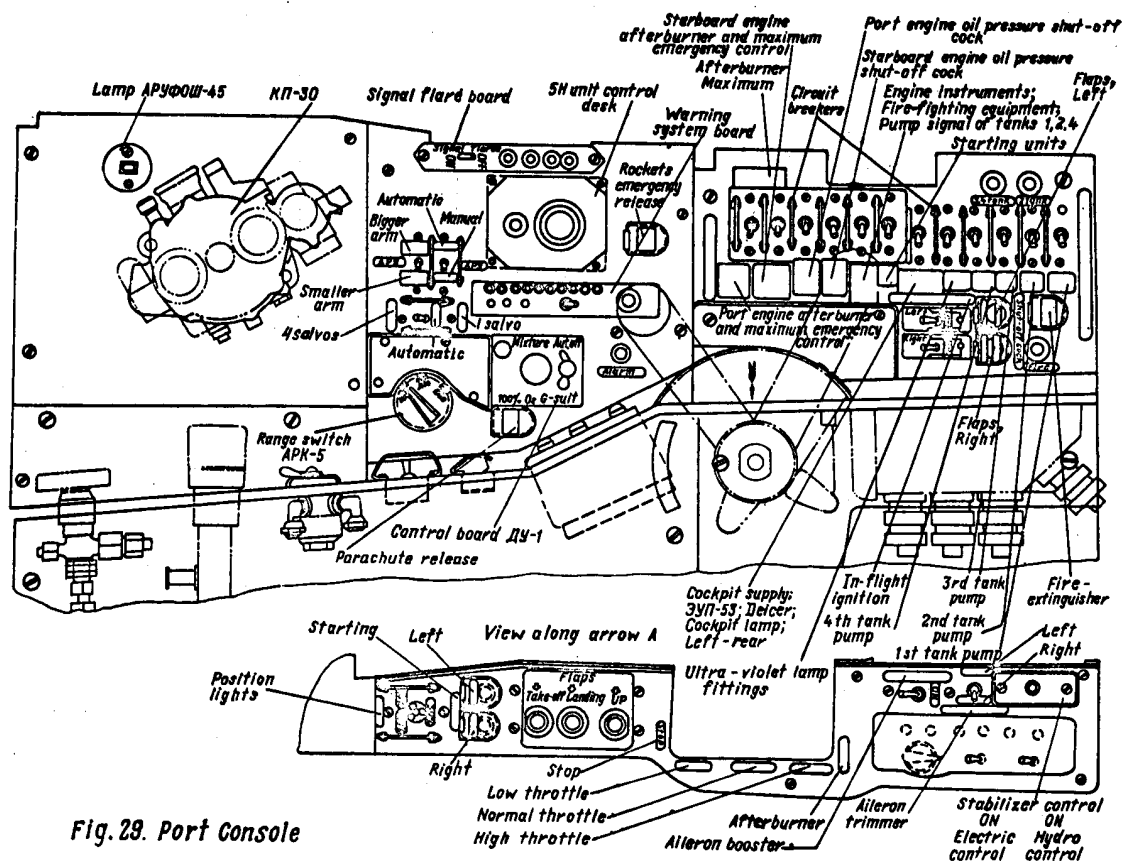


Fig. 28. Instrument Panel



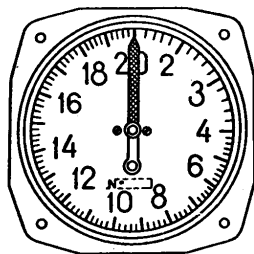
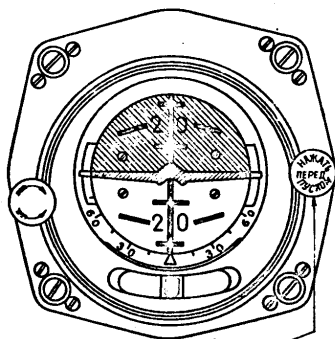


Fig. 31. Air Speed Indicator, KYC-2000



Press prior to starting
Fig. 32. Gyrohorizon AFH-1

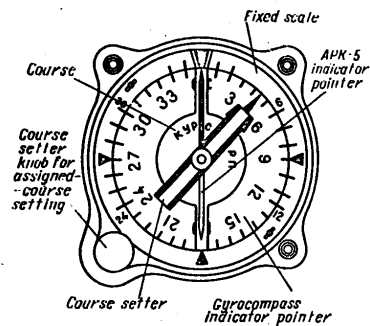


Fig. 33. Compass ГМК-1 Indicator

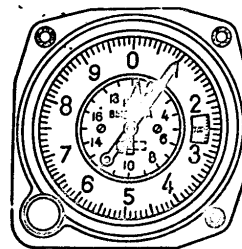


Fig. 34. Altimeter BA-20

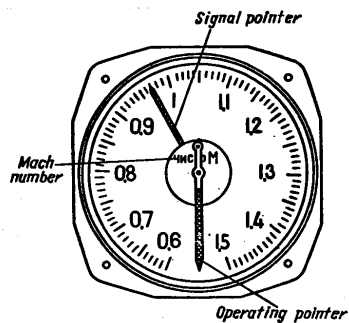


Fig. 35. Machnumber Indicator, type M-15

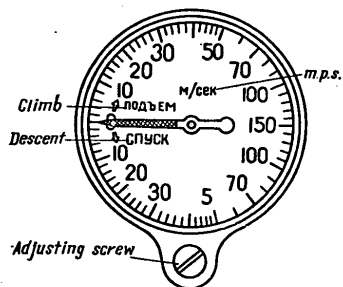


Fig. 36. Variometer BAP-150

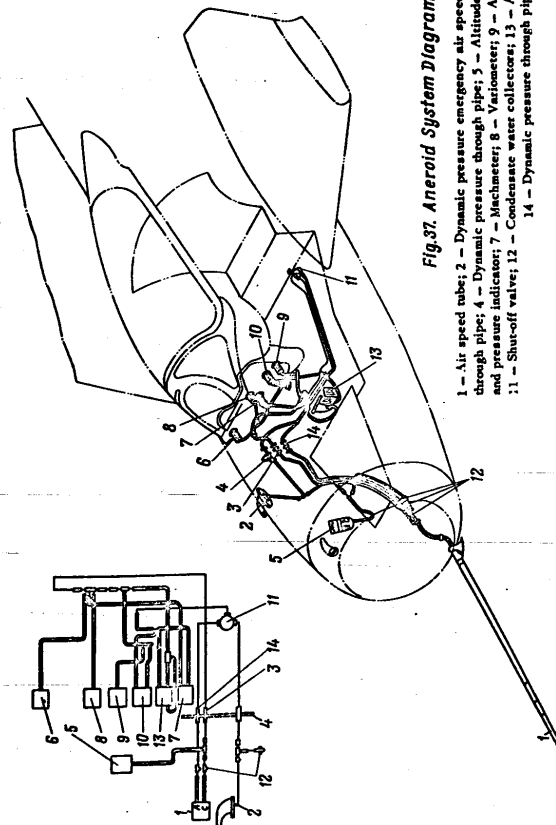


Fig. 37. Aneroid System Diagram

- 1 - Air speed tube; 2 - Dynamic pressure emergency air speed tube; 3 - Static pressure through pipe; 4 - Dynamic pressure through pipe; 5 - Altitude unit; 6 - Cabin altitude and pressure indicator; 7 - Machmeter; 8 - Variometer; 9 - Altitude; 10 - Speed indicator; 11 - Shut-off valve; 12 - Condensate water collectors; 13 - APY-2A control unit; 14 - Dynamic pressure through pipe.

50X1-HUM

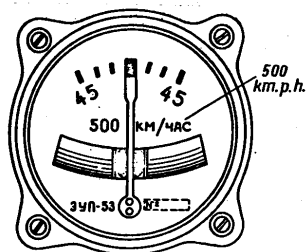


Fig. 38. Turn Indicator 3VN-53

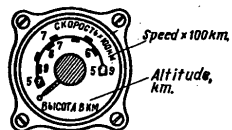


Fig. 39. Arm Position Indicator APY-2A

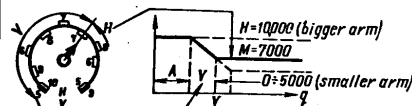


Fig. 40. Example of Using Arm Position Indicator APY

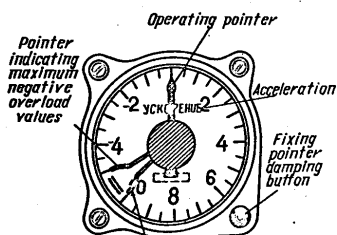


Fig. 41. Overload Indicator AM-10

50X1-HUM

50X1-HUM

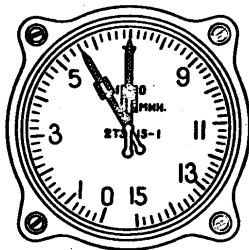


Fig. 42. Tachometer Indicator

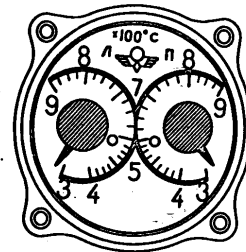
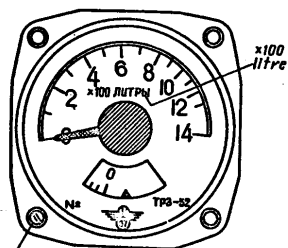


Fig. 44. Indicator. 2TBI-4



Flow gauge dial screw
Fig. 43. Indicator of Fuel Quantity Gauge and Flowmeter

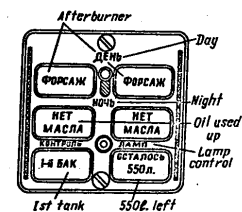


Fig. 45. Lamp Register T-6

50X1-HUM

50X1-HUM

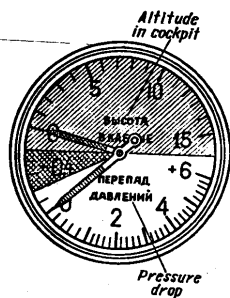


Fig. 46. Indicator УВНД-15

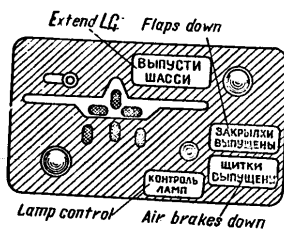


Fig. 47. Flight-Control and Landing Instrument Board ННс-2

50X1-HUM

50X1-HUM

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